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The Creation and Validation of a Pilot Selection System for a

Midwestern University Aviation Department

By

Jacob W. Forsman

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In

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Abstract

The current study outlines an attempt to create a selection test for a Midwestern university aviation department pilot training program. Thirty-seven pilots were given a pre-test consisting of cognitive (math, arithmetic reasoning, spatial measures, table reading, and mechanical knowledge), attitudinal (cockpit management attitudes questionnaire- CMAQ), and personality questions (IPIP items, Achievement-Striving, Impatience/Irritability, and the Academic Motivation Scale). An additional measure of professionalism was collected during the training program. Following the completion of a 25-lesson course in flight training, pilots were assessed on performance throughout the initial flight course. The performance ratings ranged from supervisory ratings to hours used to complete the lessons. Though the main research question was largely exploratory in nature, five specific hypotheses are outlined in the paper. Correlation analyses and both curvilinear and linear regression analyses were run in order to assess any significant relationships between the pre-test and flight performance in the program. Results indicated several positive relationships, namely between motivation, hours taken to complete the lessons, and overall performance, as well as a measure of professionalism and overall performance. Limitations and implications are discussed in the paper.

The Creation and Validation of a Pilot Selection System for a Midwestern University Aviation Department

Aircraft pilots have a unique set of skill requirements when compared with jobs in typical office settings. Although some components of a pilot's job function much like that of any other profession (such as working as part of a team, punctuality, and reporting to a supervisor), the act of flying a plane leads to actual physical and mental requirements that are different than many professions. For example, some of the task statements listed under "Airline Pilots" are: "use instrumentation to guide flights when visibility is poor," "respond to and report in-flight emergencies and malfunctions," "inspect aircraft for defects and malfunctions," and "monitor gauges, warning devices, and control panels to verify aircraft performance and to regulate engine speed" (O*NET Online, 2010). However, regardless of the similarities and differences, pilots need to be selected for positions just like in any other profession. This leads to the need for aircraft pilot selection tests for a range of positions.

Selection tests have a long history within the field of psychology. Employee selection, as it is referred to in the psychological literature, is defined as the process of choosing men and women to fill a position within a company. Selection tests are a means to do just that (Kornhauser, 1922). These tests have classically involved a battery of paper and pencil questions that are purportedly related to performance on that particular job. With the addition of technology, however, selection tests have begun to involve techniques such as computer-based simulations and even three-dimensional simulations, where an applicant can manipulate situations as if he or she were in a real job environment.

Psychological research comes into play a great deal in the creation of all types of these selection tests. Beyond the initial job analysis (an essential step in determining what knowledge, skills, and abilities are needed for the job in question and what can be labeled as job performance), psychologists put a large amount of effort in assessing how well the initial test questions relate to the overall performance as well as the individual facets of the job (Gatewood, Feild, & Barrick, 2008). Such an assessment of a particular selection test's validity not only helps show the utility of the test, but it also plays into legal requirements. Specifically, it does so by showing that a test does not discriminate against protected groups, in accordance with the Equal Employment Opportunity Commission (EEOC) federal guidelines (Gatewood, et al., 2008).

Initially, selection tests were developed during World War I. Yerkes and colleagues worked on what were two of the first selection tests for the United States Military, Army Alpha and Army Beta (Kornhauser, 1922, Muchinsky, 2003). These tests were developed in order to assess the intelligence of soldiers in the United States Army and place them in various positions within the Army. By the time the tests were fully organized and ready to be implemented, the war ended. Despite this, the use of psychologists throughout the war popularized the use of psychology in applied fields (Muchinsky, 2003).

Selection tests have appeared in the military literature in many forms. This has included tests for placement within the army (e.g., the Army Alpha and Army Beta), entrance into officer positions (such as the ASVAB, the Armed Services Vocational Aptitude Battery), and even tests for assessing students' ideal positions upon joining the military (a popular use of the ASVAB – U.S. Military, 2011). Cognitive, intelligence, and personality tests, similar in characteristics to the original Army Alpha and Army Beta tests, are typical in military selection. These tests are easy to administer, cheap to score, and have proven to be useful in the past (e.g., Carretta, 1987; Carretta, 2000; Carretta & Ree, 1993; Carretta & Ree, 1994; Tuddenham, 1948).

In addition to the standard forms of selection tests, during World War II, the Army Air Corps determined that those who had built model aircraft as children ended up as more successful fighter pilots (Changing Minds, 2011). Though multiple conclusions could be drawn from such a finding, such as the interest as a child simply being correlated with any number of later experiences and opportunities, the idea of personal interest playing a role in successful performance is an interesting qualitative finding that approaches the pilot selection question from a new angle.

Aviation and pilot selection has a similar history to that of general employee selection. Based initially in the military realm, pilot selection has since expanded to more commercial (as well as private) aspects of flight training programs. This expansion is presumably the result of the high costs of training and operating aircraft, as training programs require a substantial investment and the aircraft come at a high cost to purchase and maintain (Martinussen, 1996). Additionally, the safety concerns involved with aircraft require a high level of confidence when choosing future pilots, as pilots have the potential to put a large number of people at risk, as well as damage expensive property (Martinussen, 1996). The attempt to accurately predict pilot performance has been going on for decades with a large amount of the focus being on the United States Air Force (e.g., Carretta, 1987; Carretta 1997; Carretta, 2000; Carretta & Ree, 1993; Carretta & Ree, 1994), but also with some focus on the commercial airlines (e.g., Butcher, 1994). As a result, a large number of psychological tests have been used to assess performance. Unfortunately, many of these psychological tests tend to yield rather low validity coefficients (Martinussen, 1996).

Although many authors have outlined the prevalence of attempts to find relationships between psychological personality inventories and pilot performance over the years, consistent relationships are not always found (Siem, 1990). Specifically, Siem tested 509 USAF undergraduate recruits on a variety of self-report personality measures. Ultimately, although hostility, self-confidence, and values flexibility were related to performance within the training program (measured by either a pass or fail marking for the outcome), no measure provided predictive validity regarding selection of new pilots above any of the standard selection measures already used by the U.S. Military.

A 1991 meta analysis (Hunter & Burke) found a validity coefficient of only .11 for personality measures when used to select pilots overall. Personality measures were defined as a combination of any type of self-report measure of individual characteristics. Although this validity coefficient is not extremely descriptive on its own, as there is an extremely large variance of personality measures, it does give an estimate on the predictive validity of personality measures in aviation selection.

More specifically, over four decades ago Jessup and Jessup (1971) used the Eysenck Personality Inventory (EPI) to assess 205 Royal Air Force cadets. The EPI, a measure that assesses a participant on the neuroticism/stability and extraversion/introversion constructs, was given to the cadets early on in their training. The goal was to determine where cadets who passed and failed tended to fall on a combination of the two dimensions. Statistically significant findings noted that the failure rate was the highest for the neurotic introverts. Additionally, the failure rate was the lowest among stable introverts. Eleven years later, Bartram and Dale (1982) did a follow-up study and also found significant relationships between the EPI and success at training. Specifically, they found that successful pilots had lower neuroticism scores and higher extraversion scores when compared with the general population. These studies, while using much of the same data, were able to note different patterns among both successful and unsuccessful pilots, as well as pilots and the general population.

Using the Minnesota Multiphasic Personality Inventory-2 (MMPI-2), Butcher (1994) analyzed the profile of commercial airline pilot applicants as they compared with that of the normal population. Given statistically significant differences in the test results, it would seem that a separate personality profile might really exist for pilots. Though predictive validity is not assessed, the study does allude to the idea that personality differences could be valid predictors, if the right combination of variables is assessed.

Another study used cluster analysis to attempt to build groups of personality traits that correlate with particular aspects of training success in an aviation program. Although the goal of two rounds of data collection was, in part, to predict a level of attitude change in pilots during training rather than on flight performance and training success, three clusters of personality traits did consistently predict performance. The first cluster consisted of individuals with high levels of instrumentality, expressivity, mastery, and work orientation and low levels of negative instrumentality and verbal aggressiveness. The second cluster consisted of high levels of instrumentality, negative instrumentality, verbal aggressiveness, work, mastery, and competitiveness and low levels of positive expressivity. Contrastingly, low scores on instrumentality, expressiveness, mastery, work, and competitiveness characterized the third cluster. Ultimately, cluster number one was optimal for environments with close interpersonal coordination, such as in multicrew aircraft. Cluster number two was optimal for individual assignments, such as piloting small aircraft, while the third cluster was harder to classify, but were deemed as having lower overall motivation (Chidester, Helmreich, Gregorich, & Geis, 1991).

Other research has gone about the assessment of personality and flight performance during training from the opposite perspective. Davis, Fedor, Parsons, and Herold (2000) attempted to determine the influence that flight performance during training had on self-efficacy. As expected, the authors found that better training performance and higher initial self-esteem led to higher levels of self-efficacy in future endeavors.

Ultimately, though multiple methods of measurement and analysis have been attempted and different measures have been used in the past, it would seem that matching the context of the job and the type of personality measures ultimately make the most difference (Gatewood, et al., 2008). However, some authors have argued that a large reason for a lack of predictive validity when it comes to personality data is simply the lack of time allotted for the measurement of performance. In other words, the personality differences that do exist in applicants do not manifest themselves in flight performance differences during the relatively short period of time allotted to training, but rather they may result in performance differences during a longer period of time on the job (Chidester et al., 1991).

Clearly, personality has consistently been examined with respect to predicting performance for its ease of measurement and, in the case of the current study, is used to assess new theories based on particular characteristics of the aviation program of interest. The reason for including personality measures that have shown only minimal predictive validity stems not only from multiple interviews with the chief flight instructors involved in the current program of interest, but also from the idea that the current research will yield slightly different results than many of the previous studies, as it based in an academic university setting, rather than a military or commercial setting.

However, there is no reason to suspect that cognitive ability should not also appear as a strong predictor of aviation performance, just as it is a consistent across countless other professions (Gatewood, et al., 2008). Referring back to Martinussen's 1996 meta-analysis, it can be seen that cognitive ability tests in general have a mean correlation coefficient with overall flight performance of .24. Additionally, we see the exact same correlation coefficient for psychomotor/information processing and overall flight performance, and a correlation coefficient of .16 for intelligence in general and overall flight performance. While cognitive ability has the potential to bring nothing unique above and beyond any other predictors of flight performance, it is typically seen as an important prerequisite for many professions, aviation included.

Situational awareness is another term that frequently comes up in aviation literature, as well as in the flight instructor interviews completed for the current research. Situational awareness refers to the ability of a pilot to monitor the surrounding environment while flying and not solely pay attention to one single component, such as instrument readings. According to the author's interviews with the current program flight instructors, this skill is a large determinant of success in the program. In an attempt to assess the correlates of situational awareness, Endsley and Bolstad (1994) administered a battery of tests to 21 pilots and assessed their situational awareness ability using the Situational Awareness Global Assessment Technique (SAGAT). The authors found that spatial and perceptual measures were significantly correlated with situational awareness.

Performance outcomes for aviation training programs have been measured in multiple ways in the past. Martinussen (1996) split measures of performance into three categories: pass/fail in pilot training, ratings (of various sorts) of pilot performance (typically by instructors), and grades from pilot training in theoretical and classroom subjects. Typically, pass/fail ratings were most common, ratings came in second, and grades were not common at all, and were not used in all test categories. For instance, for cognitive tests, the total N for Pass/Fail ratings was 14,689, while it was only 4,285 for ratings, and a mere 1,181 for grades. For personality tests, however, the overall N for Pass/Fail was 5,771, while it was 1,719 for ratings, yet no studies using grades reported usable information here.

Noting such discrepancies is not to say that no studies using personality used grades as performance, nor that the large differences between methods reported are not in part due to the availability of data for the particular meta analysis. However, it does remain evident that Pass/Fail remains a very common use of a performance criterion. Because a simple “yes” or “no” yields no sensitivity regarding the differences in performance between pilots, the current study will attempt to define performance in multiple facets, including: Pass/Fail, ratings (both self- and instructor-ratings), time taken to complete training, as well as various measures reflecting situational awareness, preparedness, and decision-making.

The current study includes a personality measure that has yet to be used in aviation research: academic motivation (Vallerand, Blais, Brière & Pelletier, 1989). Academic motivation is being included as a result of the university setting, but also due to the qualitative descriptions the flight instructors had regarding the appearance of a strong correlation between completing readings on time and success in the program. Further, it is expected that academic motivation to play a larger role in the current research, as the goal is not only simply to predict performance during flights, but also the likelihood of dropping out of the program.

The needs analysis performed for the current study, derived from the flight instructor interviews involved in the current program of interest, consisted of several meetings with key personnel in the aviation department and airport staff over the course of several months. These meetings gave the authors detail into what characteristics the program has looked for in the past and what personality and cognitive abilities appear to be correlates of success in the particular program.

Overall, the current research is centered on creating and testing a new compilation of questions to be used as a selection test for a Midwestern university aviation program. The test, to be used to select future students for the pilot training program, was developed using both the incoming class and a portion of the second year students, in conjunction with their performance throughout the actual flights during training. A selection test is of great interest to the department as no test is currently administered that has a significant degree of predictive ability. With the cost of the aviation program being much higher than those of other university degrees, there is a large benefit in determining which students have potential for high levels of success and which students are less likely to drop the program mid-way through.

However, the test will serve an additional benefit as a way to design interventions for pilots who may eventually display performance deficiencies in certain areas. Specifically, if the program can pinpoint a problem area early on in the flight training process, there is potential to intervene and help remove barriers to performance before they become more problematic.

Hypotheses

The first hypothesis predicts a positive relationship between spatial awareness and situational awareness. The second hypothesis predicts a positive relationship between overall flight performance and the academic motivation scale (AMS) subscales. A third hypothesis predicts a positive relationship between overall performance and the professionalism measure. Additionally, it is hypothesized that a positive correlation will be found between overall flight performance and the impatience/irritability and achievement striving scales. A curvilinear relationship is also expected regarding the adventurousness components and overall flight performance, such that flight performance will be highest at a moderate level of adventurousness. Finally, I will conduct several exploratory investigations to help inform future research on the topic.

Method

Participants

Thirty-seven pilot students from the aviation department of a Midwestern university took the pre-test, though only 18 participated in the performance measure after the first stage of the private flight training was complete. Of the total sample, the majority of participants are male (89%), the average age is 19.89 (SD = 4.43), and all of the participants listed English as their native language. Further descriptive information includes previous hours of flight experience (M = 16.84, SD = 33.77). Of the 18 participants used currently, their average age is 19.44 (SD = 2.81), there is only one female, and the average hours of previous flight experience is much lower (M = 4.36, SD = 12.81) than that of the full sample.

Research Design

The selection test battery of questions given before flight training served as the predictor variables for the criterion: flight performance throughout the course of the lessons. Regression analyses and Pearson correlations were used to determine which of the selection test questions serve as the best predictors of performance throughout the first lesson of training.

Measures

The battery of questions was developed using a combination of previously available items. These items were chosen based on previous pilot selection research as well as using interviews with various subject matter experts (SMEs) within the aviation department.

Predictor Variables. The primary portion of the test was a compilation of cognitive tests, including mathematics, spatial reasoning, table reading, and mechanical knowledge (tests were adapted from Peterson's Military Practice Tests). The remainder of the test was constructed based on a combination of previous research and the SME interviews. This portion was the personality assessment. Specifically, there were sections on cockpit management (CMAQ-Gregorich, Helmreich, & Wilhelm, 1990), various questions taken from the International Personality Item Pool (total items used assessed: Bravery, Depression, Anxiety, Neuroticism, Self-acceptance, Excitement-seeking, Immoderation, Recklessness, Harm avoidance, Morality, Vulnerability, Dutifulness, Rebelliousness, Self-discipline, Immoderation, Cautiousness, Self-control, Risk avoidance, Self-consciousness, and Adventurousness– see Appendix A for this assortment), a section on impatience and achievement striving (Spence, Helmreich, & Pred, 1987), and a section on academic motivation (Vallerand, et al., 1989).

Overall, the test consisted of 106 cognitive questions, 96 of which were timed, and an additional 93 personality questions. A demographic questionnaire was given to assess age, flight experience (in multiple facets, including aircraft type and ground school type), background in aviation, and whether or not English was the first language of participants (see Appendix B).

Performance Variables. Additionally, ratings from the chief flight instructor were used to assess performance. These ratings were on a 10-point likert-type scale, and assessed the competencies of situational awareness, professionalism, decision-making, and overall performance. The professionalism component is derived from an additional measure collected regarding how often the pilots show up dressed appropriately, with lesson material completed, on time, and completed flight plan and other pre-flight preparations. These measures of professionalism are a part of the FAR Part 141 regulations and are assessed by the instructor before each flight lesson begins.

The Federal Aviation Administration (FAA) developed the performance measure under the Federal Aviation Regulation (FAR) Part 141 federal regulations[1]. The performance evaluation consists of 25 separate pages for the 25 lessons that the pilots must complete. These evaluations include a list of maneuvers to be completed during each lesson, some of which overlap across lessons and some of which are new. Completed maneuvers receive a checkmark, while once the pilot has reached a level of proficiency at a particular maneuver, they may receive a "P" instead of a checkmark. The researchers cannot edit this evaluation form, but flight instructors are encouraged to add qualitative descriptions to the checklists of completed maneuvers. Additionally, the number of hours a pilot takes to complete all lessons is recorded. Some lessons are repeated if not all requirements were met for a particular lesson.

Procedure

The test was given in two equal parts during the first week of class. During the first class session, the test was proctored in two different rooms, one for the new students and one for the more experienced students. This separation was not intentional, but was a result of the nature of the classes that the participants were already taking. All students in the experienced class took the test, while almost all in the incoming class took the test (those who are not intending on taking private flight training were asked not to complete the test).

Three sections of the cognitive assessment were given during day one and all three sections were timed. On day two, three more cognitive sections were given, the first two of which were timed. The remaining cognitive items and personality items were untimed. Upon

[1] Part 141 is one of the FAA Federal Aviation Regulations for flight training programs. In part this regulation defines the minimum requirements for pilot training and certification.

completion of the test on day two, the participants then completed a short demographic questionnaire.

The criterion was collected throughout the course of the semester. The FAA regulates the performance information that must be collected under FAR Part 141 restrictions. This data was collected for each flight (average of three per week) that a participant made. The data was compiled in a format that allowed for a relationship to be assessed between the selection test and the performance variable. Each pilot's own individual flight instructor assessed the performance for each participant using the FAA regulation checklist. The flight instructors were trained on the performance assessment according to FAA regulations, and were encouraged to enter any extra qualitative data that they deemed important in assessing performance. The chief flight instructor ratings were administered after the entire set of flight lessons had been completed for each student, which consisted of professionalism, situational awareness, decision making ability, and overall flight performance.

Results

IPIP items from multiple scales were combined into relevant subscales before any analyses were run. Fourteen items made up the Excitement/Adventure scale ($\alpha = .78$). A Bravery scale was compiled of seven items ($\alpha = .80$). A Self Discipline subscale was created using nine items ($\alpha = .75$). Finally, an Anxiety/Neuroticism scale was created using five items ($\alpha = .70$). The separate Achievement and Impatience/Irritability scales (seven and five items, respectively) were compiled into two separate scores as well (A: $\alpha = .69$; I/I: $\alpha = .76$).

The AMS was divided into the original author's seven intended subscales: Intrinsic motivation (to know, toward accomplishment, to experience), Extrinsic motivation (identified, introjected, and external regulation), and Amotivation. The cognitive test components were compiled into their own categories, including an overall composite: Math, Arithmetic Reasoning, Block Counting, Rotated Block, Table Reading, and Mechanical Knowledge. Means, standard deviations, and correlations between each predictor and each performance measure are located in Table 1.

Regarding the first hypothesis, where it is believed that there is a positive relationship between the two spatial awareness measures (block counting and rotated blocks) and situational awareness, no evidence was found. Specifically, a Pearson correlation revealed no significant correlations between the predictor variables and the instructor's rating of a pilot's situational awareness ability (see Table 1). However, it should also be noted that block counting was significantly positively related to the decision-making component, one of the performance variables assessed by the chief flight instructor.

The second hypothesis, regarding the expected positive relationship between overall flight performance and the academic motivation scale (AMS) subscales, showed promising results. As can be seen in Table 1, although no significant correlations exist solely between the seven subscales and overall performance and the hypothesis is therefore not supported, five of the seven subscales have a significant positive correlation with the hours taken to complete the 25 lessons. Using stepwise regression, it was found that only an intrinsic motivation to know significantly predicted a greater number of hours taken to complete the lessons, $\beta = .575$, $t(15) = 2.721$, $p = .016$. Further, intrinsic motivation to know explained a significant portion of the variance in hours taken to complete the lessons, $R^2 = .33$, $F(1, 15) = 7.41$, $p = .016$. Additionally, though not directly a part of the hypothesis, it should be noted that a significant negative correlation was found between overall flight performance and hours taken to complete the lessons, $r(17) = -.45$, $p < .05$.

The third hypothesized relationship, between professionalism and overall flight performance, showed positive results. A Pearson correlation analysis revealed that the two variables were moderately significantly positively correlated, $r(18) = .38$, $p < .10$. However, using a regression analysis, no significant prediction model was found, $\beta = .381$, $t(16) = 1.647$, $p = .119$.

No evidence was found for the fourth hypothesis, stating that a positive correlation will be found between overall flight performance and the impatience/irritability and achievement striving scales (see Table 1). Finally, no curvilinear relationship was found regarding the adventurousness component and overall flight performance, $\beta = .04$, $t(16) = .160$, n.s.

Discussion

The goal of the current study was to build a selection and screening test for a Midwestern university aviation department aircraft pilot training program. Although there were a few specific hypotheses that will be discussed shortly, the author was also tasked with looking for any potential relationships in an entirely exploratory manner. Unfortunately, other than the few significant relationships described in the results section, no other relevant and meaningful relationships were found in the data.

The first hypothesis was not supported. This hypothesis predicted a positive relationship between both the rotated block and block counting (spatial awareness) pieces of the pre-test and situational awareness. Although previous research did find positive relationships between spatial/perceptual measures and situational awareness (Endsley & Bolstad, 1994), the current study was not able to recreate these results. However, there are a few limitations in this respect. First and foremost, the current research was not able to utilize the SAGAT measure used in the aforementioned study to assess situational awareness, but instead only utilized a single measure of situational awareness using a Likert-type scale. Additionally, the spatial/perceptual measures were not identical to those used in the past. However, as noted previously, the block counting measure was significantly positively correlated with the Decision Making Supervisory Rating. Though this only indirectly relates to this hypothesis, it allows one to speculate about the relationships that at least some of the cognitive measures may have with decision-making abilities. This block counting task involved conceptualizing a stack of blocks in a three-dimensional environment and visualizing how many different blocks are touching the block in question. Though there is a perceptual component to this test, the fact that it was timed may lead to measuring a person's ability to quickly make these spatial decisions, just as one may have to do in an aircraft.

The second hypothesis, relating motivation to overall flight performance, yielded rather interesting results. Though the hypothesis was not directly supported, the analyses indicated a possible indirect relationship. All three intrinsic motivation scales and two of the extrinsic motivation scales were positively correlated with the number of hours taken to complete the 25 lessons. A stepwise regression revealed that only the "intrinsic motivation to know" scale was a significant predictor of hours spent on lessons, in that the more motivated you are, the longer to take to complete the lessons. Although five subscales were significantly correlated with hours spent on the lessons, four were left out of the regression equation due to issues with multicollinearity. Between these two main ideas, it is possible to conclude that those who are more motivated, especially to know, are more likely to take a longer time to complete the lessons. This relationship may be present solely because they may want to spend more time on each maneuver in order to fully learn each aspect. However, the negative correlation between flight hours and overall flight performance ratings may lead to other interpretations. One such interpretation is that although those more motivated to learn may take longer to complete the lessons, they are not actually performing the maneuvers better. In other words, the motivation to learn is not correlated with the physical and mental ability to complete the maneuvers proficiently, just to take the time to learn it solely on a knowledge level.

On a solely monetary- and utility- based perspective, one could speculate recommending that those who are more motivated to know and learn not be accepted into flight programs. Although this recommendation seems intuitively backwards, if motivation leads to longer hours (which leads to much higher overhead costs for the airport and program), but not to better performance, than there is little benefit to accepting such people. However, before such a recommendation should be fully instated, more investigation is necessary. It is possible that there is a secondary variable at play here that is the dominating factor. For instance, a higher "motivation to know" might actually be paired with some other variable, such as cautiousness, or another personality variable that may be explaining the lowered performance scores.

The researcher also speculated that there might have been a difference in previous flight hours completed between those who were high in intrinsic motivation and those who were low in intrinsic motivation. This speculation was based on the idea that those who entered the program with little previous experience did so because they were highly motivated to learn. Conversely, those who had more experience flying were in the program because they knew they could fly and were more comfortable with it. This notion is partially supported by the fact that, after performing a median split on the intrinsic motivation subscale, an independent samples t-test showed that those in the high motivation group had (not significantly) lower levels of experience than those in the low motivation group. This makes one wonder if the real reason for the intrinsic motivation results yielding more hours taken to complete the hours yet lower performance is really due to a previous experience issue. However, it should be noted that this analysis was performed with a statistically significant outlier in the low motivation group. It is not entirely uncommon to join the program with this level of experience (55 hours), and so, although technically an outlier, this data point was left in.

Professionalism and overall performance, the third hypothesis, was supported. Although no prediction model was found, a strong correlation between the two did exist. However, it should be noted that both of these measures were given by the chief flight instructor, and therefore may be subject to mono-method bias inflations. However, given the meaning of the professionalism component (that a person be on time, dressed appropriately, have completed preflight planning, and completed the readings), it is not a far stretch to imagine that such behaviors would relate to flight performance. However, the professionalism measure has a unique characteristic. It is by no means considered a dependent variable (performance). However, it was collected afterwards, meaning that in its current form, it cannot be used to screen applicants. With this in mind, it may be important to find another way to measure professionalism components before entering the program. Although one could argue that professionalism may be related to motivation, as those who are more motivated may do those four components at a higher frequency, it should be noted that the professionalism measure was not significantly correlated with any of the AMS subscales.

The fourth hypothesis, regarding overall flight performance and the Achievement and Impatience/Irritability scales, was not supported. No significant relationships were found here. However, the results in Table 1 show that although there was no significance, the respective Pearson correlation coefficients with overall flight performance are -.26 and .35. In other words, it might solely be an issue of the sample size being only 17. Given that, the directions of these two relationships are rather discouraging. Results show that it is possible that those who are more irritable and less achievement-oriented may actually perform better. Again though, more investigation is needed before such a conclusion be drawn. It might be possible, as in the case of hypothesis two, is that something else is actually driving this relationship, other than both achievement orientation and impatience/irritability. However, with the current data, we cannot test for this. Additionally, as the results are not significant, it is possible that the directions were simply accidental.

Finally, as noted above, no evidence was found for a curvilinear relationship between risk-taking/adventurousness and overall flight performance. It was assumed that those who are too prone to risk-taking might perform worse, and those who are not willing to take any risks will perform worse. However, in the current study this did not seem to be the case. However, this does lead us to wonder if Chidester et al.'s (1991) argument about personality differences needing more time to manifest themselves in performance differences might actually be true. Alternatively, the lack of significant findings may be an artifact of range restriction; individuals with particularly low levels of adventurousness may not bother to apply to an aviation department, while individuals very high in adventurousness may not have completed high school, and thus would not be eligible for acceptance into a flight-training program.

That notion leads us to the largest limitation of the current study. The 18 students used in the final analyses only have a few months of experience, a time period that showed a rather low level of variability in scores. With that in mind, future work should attempt to measure performance across a much larger number of flight training programs for a single person (as they move from single engine planes to more complicated lessons). Along those same lines, the fact that only 18 students were be used in the analyses is a potential reason for a lack of significant results across the hypotheses (and exploratory analyses). Given that there is pre-test data for 37 pilots, there is potential to run more analyses as more performance data is collected on the remaining 19 pilots. Additionally, students enter the program every year, allowing for new pre-tests to be created and tested and more performance data to be gathered. Given the very low coefficients for much of the cognitive test (such as for the Math and Arithmetic Reasoning sections), additional tests should look for new variables that may be related, such as a way to measure professionalism a priori. One possible way to do with may be to perform structured interviews to assess the level of professionalism a person expresses. These questions would need to be calibrated and tested before use, but it is probable that one could write questions that could accurately assess a level of professionalism through interview without a high level of subjectivity.

Overall, more research should be completed, especially in the academic field of pilot selection. As discussed previously, the academic component of the flight training programs may breed a slightly different applicant, and therefore there may be slightly different results and characteristics in selection criteria, when compared with the commercial and military pilot fields. There are some promising results outlined above, though there is not nearly enough evidence to conclude anything with strong confidence. Ultimately, there is still potential for the development of a valid and practical test with high utility.

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Table 1

Correlations between each predictor composite and each Performance variable.

		Overall	Situational Awareness	Decision Making	Total Hours
	M (SD)	7.44 (.73)	7.44 (.78)	7.11 (.90)	48.35 (5.24)
Professionalism	7.61 (1.20)	.38	-.24	-.07	.10
Adventurousness/Excitement	41.28 (6.67)	.04	.03	-.02	-.06
Bravery	25.45 (4.64)	-.09	-.55*	-.21	.11
Self Discipline	34.28 (5.15)	-.27	-.51*	-.29	.46*
Anxiety/Neuroticism	9.61 (2.79)	-.22	.03	-.19	-.18
Achievement	26.61 (2.97)	-.26	-.43*	-.51*	.17
Impatience/Irritability	12.00 (3.05)	.35	.22	.06	-.38
Cognitive Score	58.56 (10.73)	.03	.06	.23	.03
Math	5.11 (1.78	-.34	-.21	-.12	.29
Arithmetic	5.67 (2.11)	-.09	.06	.11	-.17
Block Counting	10.33 (5.16)	.21	.22	.41*	-.12
Rotated Block	8.61 (1.82)	.23	.01	.17	.00
Table Reading	22.50 (4.85)	.03	-.02	.08	.00
Mechanical Knowledge	6.33 (1.85)	-.25	-.11	-.24	.38
IM - to know	20.56 (5.86)	-.28	-.62**	-.49*	.58**
IM - toward accomplishment	17.33 (5.79)	-.27	-.51*	-.37	.57**
IM - experience stimulation	12.89 (6.85)	-.13	-.51*	-.48*	.44*
EM - identified	23.39 (4.31)	-.09	-.39	-.16	.56*
EM - introjected	19.44 (6.27)	-.22	-.46*	-.42*	.55*
EM - external regulation	22.94 (5.34)	.13	.25	.01	.32
Amotivation	5.00 (2.17)	.09	.10	.24	-.26

Notes. *N*'s ranged from 17 to 18
Means and Standard Deviations given for the 18 people with performance data available
**. Correlation is significant at the 0.01 level (1-tailed).
*. Correlation is significant at the 0.05 level (1-tailed).

Appendix A

Assortment of IPIP items

	Very Inaccurate	Moderately Inaccurate	Neither Inaccurate nor Accurate	Moderately Accurate	Very Accurate
1. Take stands in the face of opposition	1	2	3	4	5
2. Don't hesitate to express my opinion	1	2	3	4	5
3. Call for action while others talk	1	2	3	4	5
4. Can face my fears	1	2	3	4	5
5. Am a brave person	1	2	3	4	5
6. Seldom feel blue	1	2	3	4	5
7. Am relaxed most of the time	1	2	3	4	5
8. Feel comfortable with myself	1	2	3	4	5
9. Am not easily bothered by things	1	2	3	4	5
10. Take things as they come	1	2	3	4	5
11. Dislike loud music	1	2	3	4	5
12. Would never go hang-gliding	1	2	3	4	5
13. Easily resist temptations	1	2	3	4	5
14. Follow through with my plans	1	2	3	4	5
15. Think carefully before acting	1	2	3	4	5
16. Investigate all possibilities	1	2	3	4	5
17. Avoid dangerous situations	1	2	3	4	5
18. Stick to the rules	1	2	3	4	5
19. Remain calm under pressure	1	2	3	4	5
20. Want to be in charge	1	2	3	4	5
21. Would never cheat on a test	1	2	3	4	5
22. Try to follow the rules	1	2	3	4	5

	Very Inaccurate	Moderately Inaccurate	Neither Inaccurate nor Accurate	Moderately Accurate	Very Accurate
23. Respect authority	1	2	3	4	5
24. Avoid dealing with awkward situations	1	2	3	4	5
25. Don't speak my mind freely	1	2	3	4	5
26. Get stressed out easily	1	2	3	4	5
27. Have frequent mood swings	1	2	3	4	5
28. Love excitement	1	2	3	4	5
29. Enjoy being part of a loud crowd	1	2	3	4	5
30. Enjoy being reckless	1	2	3	4	5
31. Act wild and crazy	1	2	3	4	5
32. Willing to try anything once	1	2	3	4	5
33. Seek danger	1	2	3	4	5
34. Waste my time	1	2	3	4	5
35. Do things I later regret	1	2	3	4	5
36. Jump into things without thinking	1	2	3	4	5
37. Make hasty decisions	1	2	3	4	5
38. Take risks	1	2	3	4	5
39. Know how to get around the rules	1	2	3	4	5
40. Panic easily	1	2	3	4	5
41. Am afraid I will do the wrong thing	1	2	3	4	5
42. Often feel uncomfortable around others	1	2	3	4	5
43. Feel threatened easily	1	2	3	4	5
44. Like to visit new places	1	2	3	4	5
45. Like to find new ways to do things	1	2	3	4	5

Appendix B

Demographic questionnaire

What is your gender? (circle one) Male Female

What is your age? ___________

How many hours of flight experience do you have? ___________________

How many of these hours have been in the last 30 days ____________
60 days ____________
90 days ____________
Past year ____________

How many ground schools have you completed? ___________
For which FAA ratings? _______________________________________

Please list all of the different airplanes that you have flown?
____
____

Do you have other college, military, or other related life experience?
____
____
____

Do you have a connection to aviation through a close family member or friend? Yes No
Please explain:
____
____
____

Is English your first language? Yes No