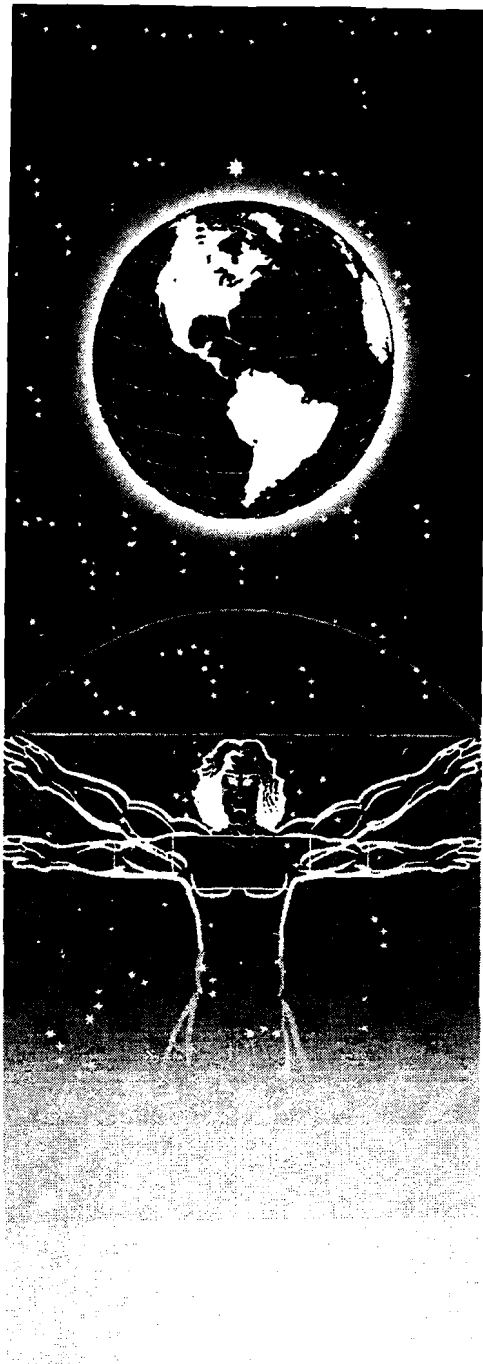


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UNITED STATES AIR FORCE ARMSTRONG LABORATORY

PERSONALITY FACTORS AFFECTING PILOT COMBAT PERFORMANCE: A PRELIMINARY INVESTIGATION

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13. ABSTRACT (<i>Maximum 200 words</i>) Reviews of the research literature have generally concluded that personality factors contribute little to pilot performance. One possible explanation for the failure to find stronger relationships may be due to the lack of appropriate taxonomies for both personality constructs and for performance constructs. The present research was designed to examine the relationship between personality and combat performance using the "Big Five" model of personality and a multicomponent model of pilot combat performance. A sample of 100 USAF pilots rated the importance of 60 traits for effective performance on performance dimensions such as flying skills and crew management. The results indicated that pilots from different aircraft agreed that the personality trait of Conscientiousness was the most important determinant of performance dimensions. Implications for pilot selection are discussed.			
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CONTENTS

	Page
INTRODUCTION	1
MATERIALS AND METHODS	2
Subjects	2
Instrument	2
Procedure	2
Analysis	3
RESULTS	3
DISCUSSION	5
REFERENCES	6

TABLES

Table
No.

1 Mean Importance Rating by Trait Factor and Performance Dimension Averaged Across Aircraft	4
2 Mean Importance Rating by Trait Factor and Aircraft Averaged Across Performance Dimension	4

PREFACE

This research was initiated by the Armstrong Laboratory, Human Resources Directorate, Aircrew Training Research Division, Aircrew Performance Branch (AL/HRAA) under Work Unit 1123-A1-08, Noncognitive Indicators of Aircrew Performance, and completed under Work Unit 1123-A1-01, Support of Pilot Selection and Classification.

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PERSONALITY FACTORS AFFECTING PILOT COMBAT PERFORMANCE: A PRELIMINARY INVESTIGATION

INTRODUCTION

Studies based on pilot performance in combat suggest that individual differences in personality characteristics are important to effective performance (1, 10, 13, 16). Jenkins, Ewart, and Carroll (10), for example, examined peer ratings from 2,872 combat pilots and identified eight characteristics associated with peer ratings of combat performance, among them leadership and responsibility, teamwork, combat aggressiveness, conscientiousness, steadiness, and sociability. Nonetheless, qualitative reviews of the literature have generally been pessimistic about the evidence of empirical support for the hypothesis that personality characteristics are important to effective pilot performance, despite the large number of characteristics examined using a variety of different instruments in a multitude of studies (7).

Recent developments in personality theory indicate that past reviews of the personality-performance literature may have suffered from the lack of suitable conceptual framework for evaluating results from different studies. Efforts to identify such a framework have led to a consensus model of personality based on the observation that five global factors adequately describe individual differences in personality traits (5, 15). These factors, known as the "Big Five," are (I) Extraversion, (II) Agreeableness, (III) Conscientiousness, (IV) Emotional Stability, and (V) Culture, or Openness to Experience (4).

The utility of the "Big Five" framework has been found in a number of recent studies using a meta-analytic framework for integrating the results of earlier studies (2, 14). Barrick and Mount (2), for example, examined a number of studies concerning personality and job performance. Their results indicated that Conscientiousness was a reliable predictor of job performance across a wide number of occupational specialties, leading to a quantitative conclusion considerably more positive than previous qualitative reviews of the personality and performance literature (9).

Just as the identification of core personality traits has led to a better understanding of predictor constructs, so has identification of performance dimensions led to a better understanding of criterion constructs and of predictor-criterion relationships. For example, results based on examining the relationship of personality constructs to one set of performance measures may vary from results based on a different set of performance measures. McHenry et al. (11) examined the relationships of predictor constructs such as aptitude and personality to criterion constructs such as technical proficiency and leadership. The results indicated that personality measures were the best predictors of criterion measures such as leadership, personal discipline, and military bearing, whereas aptitude measures were the best predictors of criteria such as technical proficiency and soldiering proficiency.

Consideration of both the "Big Five" taxonomy of personality and the concept of a multidimensional taxonomy of performance proposed by McHenry et al. (11) suggests that past failures to find reliable relationships between personality constructs and pilot performance may be due to a failure to specify which personality constructs are hypothesized to be associated with which performance components. Thus, the present research was designed to examine the perceived relationships of the "Big Five" with different components of pilot combat performance in order to empirically generate hypotheses about predictor-criterion relationships for future empirical validation research. Of particular interest to the present research was the identification of traits associated with successful performance in crew aircraft, as most previous research (1, 10, 13, 16) has focused on

single-seat, fighter-type aircraft. Research with airline transport pilots, for example, has produced somewhat different results than have data from fighter aircraft, indicating that interpersonal characteristics are of particular importance to performance in the commercial aviation environment (3).

MATERIALS AND METHODS

Subjects

The subjects were 100 USAF pilots. The majority of the pilots ($n = 90$) were captains with a minimum of 6 years service. A substantial number of the pilots ($n = 43$) had combat experience in Operation Desert Storm. Experience level varied with aircraft, from an average of 630 flight hours for pilots in the F-15 to an average of 1,850 flight hours for AC-130 pilots. The sample included copilots, aircraft commanders, and instructor pilots who were currently assigned to one of six aircraft: fighters (F-15, F-16, F-111), bomber (B-52), or transport (AC-130, C-141). The number of subjects for each aircraft ranged from 13 (F-111) to 19 (C-141).

Instrument

The instrument consisted of six rating forms. Each rating form was labeled with one of six performance dimensions (Flying Skills and Knowledge, Compliance, Crew Management/Mutual Support, Leadership, Situational Awareness, and Planning) that had been identified in a previous study (6). Each subject was asked to rate the importance of 60 traits to highly effective performance in the dimension indicated at the top of the form. The trait terms were selected from unipolar markers of the "Big Five" developed by Goldberg (8). The number of traits listed for each "Big Five" factor ranged from 4 (Emotional Stability) to 20 (Conscientiousness). Five additional ratings were made on aptitude factors that had previously been empirically validated for pilot selection. These factors were included mainly to verify that the subjects were taking the exercise seriously. Each trait and aptitude rating was made on a 7-point scale, anchored from 1 = Very Low Importance to 7 = Very High Importance. Traits were listed in alphabetical order below the rating scale.

Procedure

Two preliminary investigations were conducted prior to the current study. In the first study, pilots from one of six aircraft generated critical incidents in workshops conducted according to methods outlined by Smith and Kendall (12). The sets of critical incidents varied in number by aircraft, with a minimum of 100 (F-111) and a maximum of 150 (F-16). In the second study, another sample of pilots sorted the incidents from one aircraft into clusters representing similar performance behaviors. Data representing the co-occurrence of incidents in the same cluster were analyzed using multidimensional scaling (MDS). The results of the MDS analysis indicated that six dimensions adequately described the performance domain (6).

The subjects for the present study met with the members of the research staff in groups of four to five pilots over a 3- to 4-h period. Each subject was briefed on the purpose of the research project and then was presented with one of the six sets of critical incidents generated in the first preliminary investigation. These subjects were asked to sort or "re-translate" each incident into one of the six performance dimensions identified in the earlier investigation (12).

The subjects were next asked to evaluate the effectiveness level of each incident with regard to performance in the particular performance dimension into which it was sorted. These data were collected for the purpose of developing Behaviorally Anchored Rating Scales (BARS) for future

empirical validation studies. The effectiveness ratings were made on a 7-point scale, with end-points of 1 = Very Low Effectiveness and 7 = Very High Effectiveness.

Upon completing the incident sorting and rating task, the subjects were given a questionnaire that asked the subjects to rate the extent to which a number of traits were possessed by a highly effective combat pilot and (on a separate rating form) by a highly ineffective combat pilot. (Due to space limitations, analyses of these data are not presented in the present paper, but the results are comparable to those presented below for the attribute importance ratings.)

Finally, the subjects were asked to rate the importance of the 60 traits for highly effective performance within each of the six performance dimensions used in the previous sorting task. Trait importance was rated on a 7-point scale, with end-points 1 = Very Low Importance and 7 = Very High Importance.

Analysis

Each subject produced 360 ratings (6 performance dimensions x 60 traits). These ratings were combined for pilots who sorted a common set of incidents (i.e., by aircraft). The results were six matrices whose dimensions ranged from 13 to 17 (number of raters for a particular aircraft) and 360 (60 trait importance ratings on six performance dimensions). For each of the six matrices, interrater agreement was computed across traits for each of the six performance dimensions using Cronbach's coefficient alpha. These coefficients varied from 0.693 to 0.948. Based on these acceptable levels of agreement, the ratings were averaged across raters within a particular aircraft. The results of this process were six matrices with dimensions 60 (traits) x 6 (performance dimensions). The rating data in each matrix were then standardized to a mean of 4.0 and an SD of 1.0 to facilitate data interpretation. Finally, for each matrix, the 60-trait importance ratings were averaged (across traits ranging in number from 4 to 20) to produce importance ratings for each of the "Big Five" trait factors. Importance ratings for the trait factors were combined into a single matrix of 180 ratings (5 trait factors x 6 performance dimensions x 6 aircraft).

RESULTS

To verify authenticity of ratings, the values ascribed to aptitudes were examined for each performance dimension by aircraft. Aptitude ratings were uniformly high for each aircraft and for each performance dimension ($M = 4.67$), suggesting that the subjects did indeed take the exercise seriously.

To assess the relative importance of personality trait factors to aspects of performance in different aircraft, an analysis of variance was conducted on the trait factor importance ratings. For this analysis, the dependent measure was the trait factor importance rating and the independent measures were aircraft with six levels, performance dimension with six levels and trait factor with five levels. The results of the analysis of variance indicated that mean ratings varied by aircraft [$F(5, 100) = 2.76, p < 0.05, \eta^2 = 0.8$] and by trait factor [$F(4, 100) = 377.79, p < 0.001, \eta^2 = 0.83$]. However, the tests of the interaction terms indicated that the interpretation of the main effects for trait factor depended on aircraft type [$F(20, 100) = 5.20, p < 0.001$] and on performance dimension [$F(20, 100) = 23.34, p < 0.001$].

As the interactions were statistically significant in the analysis of variance, the mean ratings by trait factor and performance dimension are shown in Table 1 and by trait factor and aircraft in Table 2. Data in Table 1 indicate that for all six performance dimensions, Conscientiousness was rated as the most important determinant of performance ($M = 4.54$). Culture was rated as second in importance on all

performance dimensions except Crew Management/Mutual Support. Emotional Stability was rated as of average or below average importance to all performance factors. Extraversion and Agreeableness were rated as least important on all six performance factors, with one exception: Agreeableness was rated as relatively important to Crew Management/Mutual Support. Examination of mean ratings for the original trait ratings indicated that traits rated at least one SD above the mean were mostly associated with the Conscientiousness factor (Dependable, Responsible, Decisive). However, traits associated with the Culture factor were also rated as important to Flying Skills (Bright), to Situational Awareness (Foresighted, Perceptive), and to Planning (Innovative). Traits associated with Agreeableness were also rated as important to Crew Management/Mutual Support (Cooperative, Considerate).

TABLE 1. Mean Importance Rating by Trait Factor and Performance Dimension Averaged Across Aircraft

Dimension**	Trait Factor*				
	I	II	III	IV	V
Fly	3.72	3.00	4.45	3.93	4.21
Comp	3.63	3.44	4.80	3.69	3.72
Crew	3.63	3.85	4.41	3.66	3.83
Lead	3.89	3.48	4.50	3.41	4.05
SA	3.54	3.00	4.39	4.02	4.53
Plan	3.61	3.06	4.70	3.47	4.54

*Trait Factor I = Extraversion; II = Agreeableness; III = Conscientiousness; IV = Emotional Stability; V = Culture.

** Dimension: Fly = Flying skills and knowledge; Comp = Compliance; Crew = Crew management and mutual support; Lead = Leadership; SA = Situational Awareness; Plan = Planning.

TABLE 2. Mean Importance Rating by Trait Factor and Aircraft Averaged Across Performance Dimension

Aircraft	Trait Factor*				
	I	II	III	IV	V
F-15	3.71	3.25	4.54	3.85	4.14
F-16	3.73	3.27	4.570	3.48	4.06
F-111	3.62	3.22	4.56	3.49	4.26
B-52	3.65	3.25	4.61	3.96	4.09
AC-130	3.78	3.24	4.46	3.85	4.27
C-141	3.52	3.58	4.51	3.55	4.07

*Trait Factor: I = Extraversion; II = Agreeableness; III = Conscientiousness; IV = Emotional Stability; V = Culture.

The mean ratings by trait factor and aircraft type are shown in Table 2. The only difference between aircraft types in trait ratings seems to be that C-141 pilots rated Agreeableness as relatively more important for performance ($M = 3.58$) relative to the other 4 factors than did the other aircraft pilots ($M = 3.25$). Otherwise, the pilots for all aircraft agreed upon the relative importance of Conscientiousness and Culture and the relative unimportance of the other trait factors. Examination of mean trait ratings indicated that pilots for each aircraft gave the highest ratings (> 5.0) to Disciplined, Decisive, and Responsible, all associated with the Conscientiousness factor. The pilots also highly evaluated two other traits associated with Conscientiousness: Thorough and Consistent. Other highly rated traits were associated with Culture (Bright) and with Extraversion (Confident).

DISCUSSION

The findings in the present study were consistent with the analyses reported by Jenkins et al. (10), by Bair (1), and in the meta-analysis reported by Barrick and Mount (2), at least insofar as Conscientiousness was rated as the most important personality trait for pilot combat performance. The consensus concerning the importance of Conscientiousness was striking in that it transcended differences in aircraft and performance dimensions. Moreover, the agreement on the relative importance of particular traits associated with Conscientiousness was also compelling. Based on the present results, future research should be designed to identify or develop reliable measures of the Conscientiousness factor and of its constituent traits that can be empirically validated against appropriate performance criteria.

Only weak verification was generated for the importance of traits associated with Agreeableness to performance in crew aircraft, as was expected from research concerning interpersonal traits using civilian air transport pilots (3). The pilots rated Agreeableness as relatively important for performance in the Crew Management/Mutual Support dimension, but Conscientiousness was rated as the more important determinant. Further explication of these findings would benefit by an empirical comparison of the Agreeableness traits used in the current study with the measures of interpersonal orientation used by Chidester et al. (3). Of additional interest would be a replication of the Chidester et al. (3) study using military pilots rather than civilian pilots to determine to what extent the nature of the job (i.e., combat vs. noncombat) might influence the relative importance of particular pilot personality traits to performance.

The current study adds to a literature based on employing combat-experienced pilots to provide insights into the factors perceived to be associated with pilot performance using an objective, scientific approach. As such, this study is the first step in a research program to empirically examine predictor-criterion relationships. The eventual outcome of this research program is expected to be information useful to the development of selection measures for identifying the USAF pilot candidates best qualified to perform in combat as well as in training.

REFERENCES

1. Bair, J.T. (1952). The characteristics of the wanted and unwanted pilot in training and in combat. Pensacola, FL: U.S. School of Naval Aviation Medicine, Memorandum Report No. 2.
2. Barrick, M.R., & Mount, M.K. (1991). The Big Five personality dimensions and job performance: A meta-analysis. *Personnel Psych.*, 44:1-26.
3. Chidester, T.R., Kanki, B.G., Foushee, H.C., Dickinson, C.L., & Bowles, S.V. (1990). Personality factors in flight operationsI: Leader characteristics and crew performance in full-mission air transport simulation (NASA Technical Memorandum 102259). Moffett Field CA: NASA Ames Research Center.
4. Costa, P.T. Jr., McCrae, R.R. (1992). Revised NEO Personality Inventory (NEO-PI-R) and NEO Five-Factor Inventory (NEO-FFI) professional manual. Odessa FL: Psychological Assessment Resources, Inc.
5. Digman, J.M. (1990). Personality structure: Emergence of the five-factor model. In Rosenzweig, M.R., & Porter L.W. (Eds.), *Annu. Rev. Psych.* 41:417-40
6. Dittmar, M.J., Weismuller, J.J., Driskill, W.E., Quebe, J.C. & Hand, D.K. (1993). Critical incidents technique to identify attrites associated with aircrew combat performance. San Antonio TX: Metrica Inc.
7. Dolgin, D.L., & Gibb, G.D. (1988). Personality assessment in aviator selection (NAMRL Monograph 36). Pensacola FL: Naval Aerospace Medical Research Laboratory.
8. Goldberg, L.R. (1992). The development of markers of the Big-Five factor structure. *Psychol. Assessment.* 4:26-42.
9. Guion, G.M., & Gottier, R.F. (1965). Validity of personality measures in personnel selection. *Pers. Psych.* 18:135-64.
10. Jenkins, J.G., Eward, E.S., & Carroll, J.B. (1950). The combat criterion in naval aviation (Report No. 6). Washington DC: National Research Council Committee on Aviation Psychology.
11. McHenry, J.J., Hough, L.M., Toquam, J.L., Hanson, M.A., & Ashworth, S. (1990). Project A validity results: The relationship between predictor and criterion domains. *Pers. Psych.* 43:335-54.
12. Smith, P.C., & Kendall, L.M. (1963). Retranslation of expectations: An approach to the construction of unambiguous anchors for rating scales. *J. Appl. Psychol.* 47:149-55.
13. Stanley, M.D. (1973). A method for developing a criterion for combat performance of naval aviators. [Thesis]. Monterey CA: Naval Postgraduate School.
14. Tett, R.P., Jackson, D.N., & Rotherstein, M. (1991). Personality measures as predictors of job performance: A meta-analytic review. *Pers. Psych.* 44:703-42.

15. Tupes, E.C., & Christal, R.E. (1961). Recurrent personality factors based on trait ratings (Technical report ASD-TR-61-97). Lackland AFB TX: Aeronautical Systems Division, Personnel Laboratory.
16. Youngling, E.W., Levine, S.H., Mocharnuk, J.B., & Weston, L.M. (1977). Feasibility study to predict combat effectiveness for selected military roles: Fighter pilot effectiveness (TR-MDC E1634). St Louis MO: McDonnell Douglas Astronautics Co.