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A CROSS-VALIDATION STUDY OF THE PERSONALITY ASPECTS OF INVOLVEMENT IN PILOT-ERROR ACCIDENTS

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13. ABSTRACT

Pilot-error accidents have dominated accident statistics consistently from the 1940s to the present. Sanders and Hofmann (1975) found that three factors from Cattell's Sixteen Personality Factor Questionnaire (16 PF) showed significant differences ($p<.05$) between pilot-error accident groups and were used to correctly classify 86% of the aviators tested as to their previous pilot-error accident involvement. Sixty-six aviators were given the 16 PF in the present study in an attempt to cross-validate the findings reported in the original study. The results indicate that the personality factors did not significantly discriminate between the pilot-error accident groups. The primary personality differences between the present sample and the original sample were due to variations in the pilot-error accident free groups. The findings indicate that individual differences in personality characteristics of the aviators prevent consistent identification of traits associated with pilot-error groups.

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SUMMARY

Pilot-error accidents have dominated accident statistics consistently from the 1940s to the present. Sanders and Hofmann (1975) found that three factors from Cattell's Sixteen Personality Factor Questionnaire (16 PF) showed significant differences ($p<.05$) between pilot-error accident groups and were used to correctly classify 86% of the aviators tested as to their previous pilot-error accident involvement. Sixty-six aviators were given the 16 PF in the present study in an attempt to cross-validate the findings reported in the original study. The results indicate that the personality factors did not significantly discriminate between the pilot-error accident groups. The primary personality differences between the present sample and the original sample were due to variations in the pilot-error accident free groups. The findings indicate that individual differences in personality characteristics of the aviators prevent consistent identification of traits associated with pilot-error groups.

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INTRODUCTION

The problem of "pilot-error" or "human-error" accidents in aviation, by its magnitude, has forced a great deal of interest in and a variety of studies toward the examination of the human element in the aviation man-machine system. Dominance of pilot-error accidents over other cause factors has been consistently found in both military and civilian flight programs. Several investigations have reported results that illustrate the magnitude of pilot-error problems in aviation. Thorndike reported that 62.4% of Air Force accidents occurring in 1949 were listed as having the pilot as the major cause factor.[17] The National Transportation Safety Board (1973) found that pilot-error was a factor in 58% of the fatal civilian air carrier accidents occurring between 1964-1969.[8] Federal Aviation Agency statistics indicate that 80-85% of the accidents occurring in general aviation in 1972 were due to "human factors."[4] The U. S. Army Agency for Aviation Safety (USAAAVS) found pilot-error was a factor in 80% of Army aviation accidents occurring between 1958 and 1972.[12]

Webb (1956) reviewed a number of pilot-error accident studies and concluded that a percentage of the pilot-error accidents would remain unpredictable.[18] This percentage of "accidents result from conditions imposed on the individual and to which he could not respond adequately." An additional portion of the pilot-error accidents were due to "inadequate responses related to the individual pilot's 'state of readiness' to respond."[18] Webb also noted, "if these transitory or changeable states turn out to be primary determinants of accidents, the problem of prediction and selection on the basis of this prediction is awesome."[18] The transient states causation orientation "forces one to search for many different psychological factors and their significance in given environmental circumstances."[6]

Recent investigations have explored the use of a psychological autopsy or psychosocial reconstruction inventory in a postdictive manner in relationship to driver fatalities,[14,15] suicides[14] and fatal aircraft accidents.[19] A similar area addressed recently concerns life changes as related to aircraft accidents.[1] These approaches hold some promise for identifying the psychological factors involved in accidents. However, it seems that objective assessment, in a post hoc fashion, of transient states or even more permanent traits is a most difficult task.

Impact studies provided another approach to the human-error problem in aircraft accidents. Some of these studies primarily described the frequency of occurrence of various types of error[3,16] while others also utilized multivariate statistical analysis techniques to provide meaningful error groups to aid interpretation of accident causes and facilitate remedial actions.[7,8,9,12] It is of interest to note that previous accident behavior (involvement) has not been correlated with subsequent accident involvement.[18]

Fitzpatrick (1953) examined flight aptitude test scores and biographical data from classification batteries in an attempt to predict the number and kind of accidents an Air Force pilot might experience.[5] He found that it was not theoretically possible, from knowledge of test scores utilized, to consistently predict the number of accidents a pilot may incur. Furthermore, Fitzpatrick noted "that generalization of any positive results was not justified within the sample analyzed and that therefore generalization to other groups is not warranted in light of these results alone."

In light of inconsistencies in the studies investigating personal factors as related to accidents, the purpose of the present report was to present results of a cross-validation of the findings of the Sanders and Hofmann (1975) investigation.[15] In that study, three of the primary factors in Cattell's Sixteen Personality Factor Questionnaire (16 PF) significantly discriminated between Army aviators who had been listed as a definite or suspected cause factor in at least one pilot-error accident and those who were pilot-error free. These three personality variables also were used to classify the two groups of aviators as to their previous accident involvement with a "hit rate" of 86%. Therefore the present study examined the consistency of the variables found to be predictive of pilot-error involvement in the original study.

METHOD

Participating personnel for this study were 66 volunteer Army aviators (Warrant and Commissioned Officers) attending career training courses at Fort Rucker, Alabama. The subjects were tested without prior knowledge as to their previous accident involvement. Mean age of the participants was 30.1, ages varying from 24 to 50. Rank of the participants ranged from Chief Warrant Officer 2 to Lieutenant Colonel.

Scores were obtained on each aviator for the sixteen primary and four secondary personality factors from Cattell's 16 PF, Form A.[2] The 16 PF scores were corrected for age and normed with the male, age 30, general population group. A brief biographical form was also completed by each participant.

Determination of prior pilot-error accident involvement was made through examination of USAAAVS accident records. Each aviator listed as a definite or suspected cause factor in at least one aviation accident (either major, minor, or incident) was classified, for analysis purposes, as pilot-error accident involved.

RESULTS AND DISCUSSION

Personality variable scores were used as predictors in stepwise discriminant analyses for two groups. The two groups were pilot-error accident involved (PEAI) and pilot-error accident free (PEAF).

Results of the primary stepwise discriminate analysis indicated that none of the personality factors discriminated between the two groups at a probability level of .05 or less. Table 1 shows the resultant classification of aviators by personality scores into their respective groups. Prior probability of membership for the PEAI group was .23 and .77 for the PEAF group.

Table I
Number of Cases Classified (N = 66) into
Accident Groups Using the 16 PF Scores

Group	Involved	Free
Involved	0	15
Free	0	51

Descriptive data of 16 PF Scores is shown in Table II. (page 4)

A second stepwise discriminate analysis was performed using age, total military flight hours and years on flight status. These variables did not discriminate between the two groups. Descriptive data for these variables, some of which relate to accident exposure, is presented in Table III.

Table III
Means and Standard Deviations for the PEAI and PEAF Groups

	PEAI		PEAF		Combined
Variable Mean	Mean	S.D.	Mean	S.D.	Group Mean
Age	29.7	4.6	30.2	5.3	30.1
Total Flight Hours	2580.3	756.5	2165.9	1048.8	2260
Years on Flight Status	6.26	2.39	6.45	5.22	6.41

Table II

Means and Standard Deviations for the PEAI and PEAF Groups on the 16 PF Variables

Personality Variable Name	PEAI Mean	PEAI S.D.	PEAF Mean	PEAF S.D.	Combined Group Mean
Reserved vs. Outgoing (A)[a,b]	4.06	1.53	4.35	1.76	4.28
Less vs. More Intelligent (B)	7.06	1.38	6.54	1.71	6.66
Affected by Feelings vs. Stable (C)	6.00	1.77	6.33	2.01	6.25
Humble vs. Assertive (E)	6.80	2.14	6.74	1.68	6.75
Sober vs. Happy-Go-Lucky (F)	6.00	2.03	6.03	1.98	6.03
Expedient vs. Conscientious (G)	6.13	1.95	6.64	1.91	6.53
Shy vs. Venturesome (H)	5.20	2.24	6.11	2.11	5.90
Tough vs. Tender-Minded (I)	4.73	2.21	4.33	1.57	4.42
Trusting vs. Suspicious (L)	4.73	1.53	5.47	2.45	5.30
Practical vs. Imaginative (M)	6.13	1.50	5.74	1.76	5.83
Forthright vs. Shrewd (N)	5.46	1.40	5.13	2.16	5.21
Self-Assured vs. Apprehensive (O)	4.93	1.86	4.52	1.87	4.62
Conservative vs. Experimental (Q)	6.60	2.02	5.70	1.97	5.90
Group Dependent vs. Self-Sufficient (Q_2)	6.80	1.65	5.76	2.19	6.00
Undisciplined vs. Controlled (Q_3)	6.06	2.08	6.56	1.78	6.45
Relaxed vs. Tense (Q_4)	5.26	1.86	5.13	2.22	5.16
Introversion vs. Extroversion (Q_I)	5.63	2.02	6.33	1.87	6.17
Adjustment vs. Anxiety (Q_{II})	5.11	1.70	4.91	1.77	4.96
Sensitivity vs. Tough Poise (Q_{III})	7.30	1.73	7.05	1.83	7.11
Dependence vs. Independence (Q_{IV})	6.65	1.79	6.49	1.43	6.53

[a]The letter designation of each personality factor follows the descriptive variable name.
[b]Lower scores are associated with the left side of the continuum and vice-versa; average range includes sten scores five-six on the 16 PF factors.

The accident frequency distribution was also examined in relation to the Poisson distribution which is often utilized to determine if variables other than chance contribute to the actual frequency of accidents found in a given sample. Table IV illustrates the close relationship between the actual and theoretical distributions (based on a mean of 0.26).

Table IV
Comparison of the actual frequency distribution of accidents to the Poisson distribution

Accident Frequency	Actual Number of Cases	Theoretical Number of Cases
0	51	50.9
1	13	13.1
2	2	1.8
3	0	0.16

As indicated above, the cross-validation data did not exhibit the differences between groups found in the original study. Personality scores from the two studies were examined statistically with a stepwise discriminant analysis program; the two groups, PEAF and PEAI, were compared individually across the samples. Those variables, from the analyses, with F values of 2.0 or greater are presented in Table V. It can be seen that the second sample scores on Factors M and Q_2 (two of the three originally discriminating factors) reversed the direction of differences between pilot-error groups.

Four of the factors listed in Table V concern variations in scores between the PEAF groups, while only one factor exhibited differences between the PEAI groups. The greater PEAF variation suggests that perhaps these groups contained some individuals whose profiles were similar to the PEAI groups. These individuals, it could be hypothesized, might have a high probability of being involved in a pilot-error accident, with an actual accident not yet realized at the time of testing because of limited flight exposure. Conversely, it could be hypothesized that the high time aviators without a pilot-error accident should exhibit personality characteristics more reflective of aviators with a low probability of having a pilot-error accident. To test this hypothesis a comparison was made between all PEAI aviators (30) and forty-eight PEAF aviators with over 1800 flight hours (Mean - 2753.9). The stepwise discriminate analysis performed indicated no significant differences ($p>.05$) between the two groups tested. Therefore, accident exposure or flight hours, in this particular comparison, was not a discriminating factor.

Table V
Comparison of Cross-validation Data with Data from the Original Study

Groups Differing	Personality Variable	Original Data $\bar{X}$	S.D.	Cross-validation Data $\bar{X}$	S.D.	F	P
PEAF	(Factor B)	7.5	1.5	6.5	1.7	6.9	.05
PEAF	(Factor M)	6.3	1.4	5.7	1.8	3.1	.10
PEAF	(Factor Q_2)	6.9	1.5	5.8	2.2	3.3	.10
PEAF	(Factor Q_3)	5.7	1.6	6.6	1.8	5.9	.05
PEAI	(Factor Q_2)	5.1	1.1	6.8	1.7	10.4	.01

Aircraft type, mission, mission environment, total military flight hours as well as other variables contribute to a pilot's risk or accident exposure. Nine of the seventeen accidents included in the cross-validation data involved the UH-1 helicopter. This high frequency is expected because the UH-1 helicopter is utilized for a variety of missions and is the most frequently flown of any of the Army rotary wing aircraft. No consistent trends were observed when mission and mission environment was examined.

An explanation for the lack of consistency between the two studies could be that the pilot-error label simply contains too wide a variety of errors or combination of errors. For example, USAAAVS[12] has established a nine factor scheme which provides a more detailed classification of aviators according to specific errors committed. Within this scheme PEAIs in the original study contained more accidents on the USAAAVS' disorientation, procedural decision, overconfidence and crew coordination factors than those in the cross-validation study. While aviators in the cross-validation study contained more accidents loading on the USAAAVS' limited experience, task over-saturation and precise multiple control factors. However, the differences in distributions across the nine factors are of limited value statistically because of the small number of cases involved.

In the final analysis, these data indicate that individual differences in personality characteristics of aviators prevent identification of personality traits associated with PEAI and PEAF groups. Though this was not the case in the first effort these measures, as Fitzpatrick found, could not be generalized to a second sample of aviators. Of course one could not expect to account for all pilot-error involvement with personality variables because of the obvious importance of environmental, equipment design, training and situational factors. However, since the ultimate responsibility for safe flight resides with the pilot, one cannot underestimate the influence of personal characteristics upon flight performance nor completely abandon the goal of developing measures of them which can be related to performance. Toward this end, potentially productive areas of research concerning the pilot-error problem might be (1) examination of individual differences in perception of hazard, and (2) a detailed investigation of errors frequently occurring in clusters.

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