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A Comparison of US Air Force Pilot Psychological Baseline Information to Safety Outcomes

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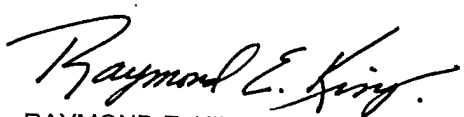
TECHNICAL REVIEW AND APPROVAL

The Office of Public Affairs has reviewed this technical report. It is releasable to the National Technical Information Service where it will be available to the general public, including foreign nationals.

The voluntary informed consent of the participants used in this research was obtained as required by Air Force Instruction 40-402.

This technical report has been reviewed and is approved for publication.



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There are many possible causes underlying US Air Force aircraft mishaps and incidents. Some are due to circumstances beyond the pilots' control, such as bird strikes and engine or control surface malfunctions. Some, however, clearly involve at least some degree of pilot error, including collisions with the ground and pilot-induced engine malfunctions. Method: Archival psychological test data related to the trait of "conscientiousness" was obtained on 347 pilots who subsequently were involved in aircraft mishaps and incidents. Data was contrasted between those who were (N=28) and were not (N=319) deemed to have played a causal role in mishaps/incidents. Results: Pilots who received high scores on subscales related to self-assurance and devotion to duty were 3.75 and 2.39 times, respectively, more likely to have pilot-error mishaps/incidents. No relationship was found between mishaps/incidents and orderliness, achievement striving, self-discipline, and deliberation. Discussion: While counter-intuitive, it may be that these traits represent a lack of flexibility of the pilots such that they are less able to meet novel demands in crisis situations. Alternatively, those with higher feelings of competence, particularly in this relatively inexperienced sample, may have over-stretched their ability. Or, perhaps pilots with these traits are more likely to report significant incidents that fall short of a mishap. These interpretations are preliminary; more cases need to be collected and analyzed.

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Abstract

There are many possible causes underlying US Air Force aircraft mishaps and incidents. Some are due to circumstances beyond the pilots' control, such as bird strikes and engine or control surface malfunctions. Some, however, clearly involve at least some degree of pilot error, including collisions with the ground and *pilot-induced* engine malfunctions. **Method:** Archival psychological test data related to the trait of "conscientiousness" was obtained on 347 pilots who subsequently were involved in aircraft mishaps and incidents. Data was contrasted between those who were (N=28) and were not (N=319) deemed to have played a causal role in mishaps/incidents. **Results:** Pilots who received high scores on subscales related to self-assurance and devotion to duty were 3.75 and 2.39 times, respectively, more likely to have pilot-error mishaps/incidents. No relationship was found between mishaps/incidents and orderliness, achievement striving, self-discipline, and deliberation. **Discussion:** While counter-intuitive, it may be that these traits represent a lack of flexibility of the pilots such that they are less able to meet novel demands in crisis situations. Alternatively, those with higher feelings of competence, particularly in this relatively inexperienced sample, may have over-stretched their ability. Or, perhaps pilots with these traits are more likely to report significant incidents that fall short of a mishap. These interpretations are preliminary; more cases need to be collected and analyzed.

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A COMPARISON OF US AIR FORCE PILOT PSYCHOLOGICAL BASELINE DATA TO SAFETY OUTCOMES

...a cross-fertilisation of information on the pivot of a corporate understanding of human factors needs to be established and maintained if we are to progress deeper into the many different areas of human understanding. One such, which so far has been avoided, is how far personality is a factor in the making of mistakes – but this minefield eventually will have to be addressed.

(David Beaty, *The Naked Pilot: The Human Factor in Aircraft Accidents, p. vii,* 1995)

The proper amount of the personality trait of conscientiousness[1] may be the secret ingredient in the formula of success in aviation. Siem and Murray (10) found that 100 experienced USAF pilots nominated conscientiousness as the most desirable quality for pilots to possess (particularly in combat). Lardent (6), perhaps paradoxically, found in a retrospective study that pilots who had been involved in a crash were more conscientious, on average, than those who had not been involved in a crash. In addition to the bias of a retrospective study, Lardent acknowledges the dangers of excessive conscientiousness, with its attendant unrealistically high standards and reluctance to quit, even in the face of adversity. Perhaps a curve similar to the Yerkes-Dodson (10) curve applies here; an inverted U, with moderate levels of conscientiousness being best. Lardent made no distinction based on the cause of the mishap - operator error vs. mechanical failure.

Perhaps conscientiousness is similar to risk taking; it is a psychological trait best to have in moderate amounts. Callister, Anesgart, Orme, and Retzlaff (3) found that a mid-range of risk-taking predicted successful completion of aviation training. Moreover, perhaps Siem and Murray's findings are not diametrically opposed to those of Lardent. Perhaps "leaning forward"[2] is a quality that is valued in some aviation situations, even when it may be to the detriment of flying safety.

Despite the title of his 1977 article, *Personality Characteristics of the High-Accident Risk Naval Aviator* (1), Alkov points to situational factors as well as personality traits as risk factors in aviation. Alkov also relied on information gleaned after aircraft accidents (12 cases). Alkov acknowledges the difficulty of uncovering information after an accident. Nevertheless, Alkov posits a deadly combination of "excess aggressiveness coupled with immaturity or impulsivity" (p. 20). Alkov, similar to Mach[3] (7), notes the similarity between high-risk aviators and the best aviators, the defining difference, however, being discipline and judgment. Finally, Alkov points to the need for teamwork.

John W. Chappelow, a British accident investigator, similarly suggests a failure of coping with stress ("overarousal") and personality factors leading to aircrew errors, in an unpublished manuscript. Chappelow also indicts "limited talent," suggesting a failure of selection techniques. Chappelow recommends the "use of personality tests to provide guidance for supervisors and counseling" (p. 8) as a possible remedy to the following two personality problems: 1.) "unstable introverts" who become overaroused in response to emergencies, and 2.)

"unstable extraverts" who seek excitement and disregard risks. The quality of being "unstable" seems to be critical here, but was not defined.

This project evaluates the value of understanding, *before* an individual is involved in an aircraft mishap, the trait of conscientiousness and its relationship to safety outcome. Previous research on psychological factors and involvement with aircraft mishaps has been retrospective (for example, Platenius & Wilde, 8, in addition to Lardent), rather than prospective. Even if those involved in the mishap survive, they are obviously not the most objective respondents. Attribution error[4] is a major problem when trying to learn about an operator *after* an incident. Another confounding factor is that not every mishap participant will survive, hence narrowing the field from which information can be gleaned.

There are many possible causes underlying US Air Force aircraft mishaps and incidents. Some are due to circumstances beyond the control of the pilot, such as bird strikes and engine or control-surface malfunction. Some, however, clearly involve at least some degree of pilot error, including, collisions with the ground and *pilot-induced* engine malfunctions

The purpose of the present study is to compare pre-existing psychological test data to human error in US Air Force mishaps and incidents.

METHOD

Instrument:

Psychometric data used in this study was obtained from the archival database of the USAF's Enhanced Flight Screening program (5), which is now

called Medical Flight Screening (MFS). This program began March 1994 and was designed, among other functions, to obtain baseline cognitive and personality measures on all individuals selected to attend pilot training and to obtain psychometric data for aircrew selection research. Psychometric measures include: a neuropsychological screening battery (CogScreen-Aeromedical Edition), an intelligence test (Multidimensional Aptitude Battery; MAB), and two personality tests (NEO Personality Inventory-Revised, NEO-PI-R; and the Armstrong Laboratory Aviator Personality Survey, ALAPS). Data for this study was obtained from the NEO-PI-R, which was designed to examine normal variations of personality in normal individuals. The NEO-PI-R assesses five factors that are believed to encompass the aspects of personality. The five factors are: Neuroticism, Extraversion, Openness, Agreeableness, and Conscientiousness. The Conscientiousness facets were used in this study; they are: Competence, Order, Dutifulness, Achievement Striving, Self-Discipline, and Deliberation.

Procedure:

Consent from the Headquarters, Air Force Safety Center (AFSC) Judge Advocate was secured during March 2000. The presiding JAG specified no privileged information be released outside safety channels; a restriction we strictly observed. Moreover, the Brooks Air Force Base (TX) Institutional Review Board approved this study as exempt[5]. Social Security numbers (SSNs) of aircraft mishap participants were gleaned from the AFSC database and matched to SSNs stored in the MFS database. Matching cases were then reviewed to determine

whether pilot error was recorded as a suspected cause in the mishap or high-accident potential incident. Of the 347 cases, 28 involved clear pilot error, while the remaining 319 involved aircraft malfunction without deleterious input from the pilot. Pilot error involved "Causes" were recorded, either primarily or secondarily, as: "collision with ground," "pilot-induced takeoff," "pilot-induced control loss," "pilot-induced engine malfunction," and "pilot-induced landing mishaps." Aircraft mishaps and incidents without deleterious input from the pilot included: "bird strikes," "landing gear failures," and "engine failures." The more thorough "Findings" and "Narrative" sections were reviewed in the case of multiplace aircraft (e.g., student and instructor pilots flying together) to determine who was in control of the aircraft. Psychological testing data from the MFS database (collected before any of the mishap events) was then merged with the safety data. The 28 pilots recorded as "causal" for their mishaps/incidents were compared to the 319 who were not recorded to be "causal."

The six variables from the NEO-PI-R relating to conscientiousness were examined (see Table 1). Odds ratios were calculated as the measure of statistical association between each of the six facets and pilot error.

RESULTS

Two Conscientiousness facets were found to be significantly associated with pilot error in mishaps/incidents, underlined in Table 1. Those scoring higher (T score > 59) on *Competence*[6] were nearly four times (odds ratio = 3.75, 95% confidence interval = 1.64 to 8.55) more likely as those scoring low on the scale to

have a pilot-error mishap/incident. Indeed, 14% of those scoring high on the facet were judged to be "at fault" as opposed to only 4% of those scoring low on the facet.

Similarly, those scoring greater than 59 on *Dutifulness*[7] were over twice as likely (odds ratio = 2.39, 95% confidence interval = 1.09 to 5.22) to have a pilot-error mishap/incident. Here, 13% of those with high scores were found "at fault" as opposed to only 6% of those scoring below 60 on the facet[8].

Table 1: NEO-PI-R Scales and Odds Ratios.

Facet Name	**Odds Ratio**	**Confidence Band**
Competence	3.75	1.64-8.55
Dutifulness	2.39	1.09-5.22
Order	1.53	0.65-3.64
Self-Discipline	1.39	0.61-3.20
Achievement Striving	1.17	0.54-2.53
Deliberation	1.05	0.41-2.68

DISCUSSION

The findings, while seemingly counter-intuitive in some instances at first glance, are consistent with Lardent (6). There are at least four possible interpretations and explanations of this data involving pilot flexibility, feelings of over-competence, incident report propensity, and mission assignment.

It may be that these traits represent a lack of flexibility of the pilots such that they are less able to meet novel demands in crisis situations. The "down-side" of conscientiousness is a stability that is a positive trait in the vast majority of flight situations. However, when things begin to go badly, it may be that these pilots are stable to the point of rigidity and lack the flexibility to correct errant situations.

Alternatively, those with higher feelings of competence may over-stretch their ability. This "over-confidence" may lead pilots, particularly those who are relatively inexperienced, to believe that their skills are higher than is truly the case. Over confidence leads these pilots to attempt things that are more dangerous than they realize.

Perhaps pilots with these traits are simply more likely to *report* significant incidents that fall short of a mishap. It is vital to bear in mind that aviation is a complex matter; the context must be appreciated. In this case that context is the differential report of incidents. Those who are very conscientious may feel it is an absolute necessity to report everything while others may not feel as compelled to report.

Finally, it may be the case that conscientious pilots are given the most demanding missions. Here the conscientiousness is appreciated by the commander and this results in higher risk situations. The risk of mishap and incident here is not of the pilots making, but rather of a differential risk potential.

Perhaps there is an appropriate time for "leaning forward," particularly in military aviation, and those who are most adept at doing so most eagerly accept

the challenge. It is not suggested that less conscientious personnel should be selected in the future as a means of reducing aircraft mishaps. Rather, there may be an optimal range for conscientiousness. The current data set is by no means large enough, nor is the context well enough understood, to determine the optimal amount of conscientiousness in pilots. These interpretations are preliminary; more cases need to be collected and analyzed. Although unfortunate, inevitably the pool of mishaps/incidents will increase. In any event, the authors do not wish to imply any judgment about the pilots involved in mishaps. James Reason sums it up the best when he asserts: "The best people can make the worst mistakes. The greatest calamities can happen to conscientious and well run organizations. Most accident sequences, like the road to hell, are paved with good intentions - or with what seemed like good ideas at the time" (*p. 21,* 9).

Just as flight data recorders have greatly improved our understanding of the status of an aircraft in the moments before it crashed; psychological data, captured before a mishap, may improve our understanding of the status of the crew before a crash. This psychological data may point to less than optimal functioning or may demonstrate the mishap aircrew's similarity to his or her peers. Longitudinal research can teach us the strengths and vulnerabilities of the humans who populate and control our aircraft.

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Elliott J. King, son of the first author, stated: "Why can't I do easy stuff like you" as he struggled with his third grade home and his father labored over this manuscript. His wish suggested the importance of one's perspective when assessing the degree of difficulty of a task.

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The views expressed herein are not necessarily those of the Department of the Air Force nor the Department of Defense.

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END NOTES

[1] Conscientious individuals are characterized by Costa and McCrae (4) as being purposeful and strong-willed. Costa and McCrae associate conscientious with academic and occupational achievement. Conversely, these individuals may exhibit "annoying fastidiousness, compulsive neatness or workaholic behavior" (*p. 16*, 4).

[2] Doing whatever needs to be done to accomplish the mission.

[3] Mach noted: "Knowledge and error flow from the same mental sources, only success can tell one from the other."

[4] As observers, we tend to attribute the behavior of others to internal factors, while we attribute our own behavior to situational factors.

[5] 19 Jun 00 (#F-BR-2000-0039-E).

[6] Costa and McCrae (4) define competence as the sense that one is capable, sensible, prudent, and efficient. Individuals who score high on this scale feel well prepared to deal with life.

[7] Individuals who score high on *Dutifulness* "adhere strictly to their ethical principles and scrupulously fulfill their moral obligations" (*p. 18*, 4).

[8] The current data, upon a sensitivity analysis, suggest no uniform 'cut score" at which pilots become more susceptible to error. Furthermore, while *Competence* and *Dutifulness* do not contribute unique predictive power, *Competence* is the more predictive of the two, as illustrated below:

Comparison of facet scores > 59 and percentage of pilots involved in human-error mishaps/incidents.

Facet	Percentage of error pilots scoring > 59
Competence	39
Dutifulness	28

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