Original Article

Accident proneness of pilots in Indian Air Force: An empirical analysis through selection criteria

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ABSTRACT

Flying is a highly complex task and there are innumerable psychological factors which traditionally have been considered as important requisites to be an aviator. The selection boards (AFSBs) adopt comprehensive psychological test batteries to ascertain the suitability of aspiring candidates for flying based on intelligence, aptitude and personality variables. Those who do not exhibit these qualities/abilities to an acceptable degree are weeded out. Despite adopting such precision in selecting the "right stuff", some mishaps still occur, which have their origin in the man controlling the machine. Human error has been implicated in 70-80% of all civil and military aviation accidents consistently since the early 40s. If such human elements responsible for these errors are identified at the selection stage itself, we can possibly minimize or even completely eliminate alarming rate of air accidents/incidents. Thus it becomes imperative to undertake a retrospective study to systematically re-examine the association between pilot selection criteria and accident proneness. The present research therefore focuses on the similarities and dissimilarities between accident free pilots and those who are not. We studied the records of 615 IAF pilots, about half of whom had "clean" records while the other half had been involved in an accident between 1973-1996. The performance of these two groups on intelligence tests, pilot aptitude battery and personality tests employed at AFSBs was analysed. Results indicate that both the groups differed significantly on pilot aptitude battery. Details are discussed.

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Key words: Accident Proneness, Aptitude, Intelligence, Personality

Introduction

Millions of rupees are spent annually by the Indian Air Force for selecting suitable candidates to fly machines in the air and millions of rupees are also lost on aircraft accidents. Ironically most of these accidents occur due to the man controlling the aircraft. Human errors are recognized as a contributing factor in as many as 80% of aviation crashes as accident statistics reveal consistently from the 1940s to the present [1].

Flying is a highly complex task and the psychological components involved in flying behavior are the necessary skills (aptitude), the ability to apply these skills efficiently and effectively when operating in air (intelligence) and the willingness or motivation to apply these skills when operating in air (personality). It has been said by many flight crews in Flight Safety Foundation interviews, that 'Pilots are the only people in the company who make multi-million-dollar decisions in a split second'. It is true-the decisions they have to make in fraction of a second can save or lose the aircraft in their charge. Anyone who is entrusted to make vital decisions of this kind has not gotten to that position by chance. All these pilots have thorough scientific selection and have intensive training behind them. How can hand-picked, thoroughly-trained decision-makers commit errors which contribute to aviation accidents? From such observations as these it has been proposed by many different sources that certain people are accident-prone. In other words,

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accidents don't just "happen", they occur because certain people have a tendency to make them.

The fact that accidents tend to cluster within individuals is a phenomenon that was first described by Greenwood and Woods early in the 20th century [2,3]. In an effort to explain this clustering of accidents within individuals, Farmer and Chambers [4] were the first to introduce the concept of accident proneness. They defined accident proneness as a 'personal idiosyncrasy predisposing individual to a higher accident rate'. This human component in accident involvement is difficult to study because of the lack of consensus on what defines accident proneness [5,6]. For almost a century, accident proneness has been the subject of many debates in medical, psychological, and sociological sciences [7]. Some researchers have even focused on studying whether accident proneness exists at all [8].

The phenomenon is defined as possession of the qualities that are harmful to safe work at a certain moment or/and lack of possession of the qualities that are indispensable for safe work at that same moment. To date there are only a few studies indicating the validity of psychological variables in predicting accident outcome [9,10]. A study by Arthur, Barrett and Alexander [10] state that of the several approaches predicting accident involvement, four categories seem to predominate and these are; personality, cognitive ability, aptitude and demographic variables. The findings were supported by a rigorous prospective study [11] of pupil pilots that showed differences in intelligence, skill, and personality between an accident group of 200 pilots and a non-accident group of 400 pilots. Dunbar [12] has made a study of a large number of accident-prone individuals and also reports that the group as a whole has certain definite characteristics which, if further studied, may be a valuable aid to prediction.

Aptitude and its relation to Flying Skill

It is contended that "good hands" were congenital and not acquired and that individuals differ from each other in their capacity to profit from training. It is essential, therefore, to estimate an individual's aptitude before he starts to learn a complex skill like flying so that wastage in training would be eliminated. Aptitude refers to inherent ability to do a certain kind of work at a certain level. Regardless of one's training, experience, and educational background, the manner in which one carries out a specific sequence of events may vary greatly. Literature on Human factors centered aviation accident analyses also report that skill based errors are known to be the cause of 80% of all accidents [13]. A study conducted on civil aircraft accidents in India revealed that skill based errors are the most common unsafe acts [14].

Intelligence in relation to Flying Performance

A pilot must understand his/her aircraft, its complications and limitations and must remain calm and collected under all circumstances to be able to make a quick and balanced decision. Therefore pilot's grasp, reasoning and cognitive ability is paramount for successful flying. Intelligence is the capacity to perceive the relations between objects, persons and situations or to do abstract thinking. Hence it becomes mandatory to assess the intellectual ability of the person being recruited and the individual differences in basic cognitive processing. Studies on USAF aircrew found that perceptual speed, decision making speed, and memory function were found to be significant predictors of flying performance [15,16].

Personality in relation to Flying Behavior

The aviation scenario encompasses many demanding and challenging situations in air and/or on ground. The personality of the aviator is likely to have its own impact on tackling or approaching

those demanding situations. Hence, knowledge about the pilot's personality and its influence on flying performance has an important bearing on flight safety**.** However it is difficult to comment on which personality profile is more suitable for aviation. Conscientiousness was considered the most important dimension and predictor of performance among the Big Five personality traits [17]. Many studies were carried out to find out whether there is any relation between personality and performance in terms of accident rates. More recent studies suggest that personality interacts with flying performance and could be one of the many factors, which contribute to accidents or incidents [18]. A wide ranging group of personality factors have been shown to be related to accident prone behaviour.

Accident-prone aircrew share certain personality traits, which may make them vulnerable to accidents. If a pilot is highly accident prone, he or she may commit errors either by an act of commission or omission [19]. Some factors found in this syndrome were excessive aggressiveness, impulsivity, decreased tolerance for tension/stress, resentful of authority, less in harmony with environment, being ego involved and hence overtly sensitive to criticism of flying abilities, strict moral and/or religious upbringing, financial problems, recent major career decision and difficulty with interpersonal relationships [20]. An exploratory study [21] found that three of Cattell's sixteen personality factors correlated highly with accident history. The investigators were able to determine with 86% accuracy whether a pilot had previously been involved in a pilot error. As defined by these three factors, pilots in this accident group were more group dependent, practical and shrewd. But a cross validation study made on another group of pilots failed to replicate these findings [22].

Lardent [6] used Cattell's profile to assess the differences between a group of Phantom fighter pilots who "crashed" versus those deemed to be "safe". It was concluded that this particular group is in clear opposition to Cattell's generic profile and constitute a special case, where conventional views of accident behaviour do not apply. What is clear from this study is that there are identifiable patterns of personality characteristics that set apart those having accidents from those who do not, and that this information can be drawn from standard psychological tests.

All these three variables viz. aptitude, intelligence and personality are currently being considered to ascertain the suitability of candidates aspiring to become pilots at various Air Force Selection Boards (AFSBs). Flying aptitude is tested in the form of an aptitude battery, generally termed Pilot Aptitude Battery (PAB). Performance on PAB reveals whether a candidate has adequate aptitude to learn flying but does not reveal whether he is accident-prone. Intelligence is measured by a battery of power tests and the performance is indicative of the basic intelligence of a pilot which is termed as 'Officer Intelligence Rating' (called OIR). The personality of the aspiring candidates is assessed in terms of fifteen Officer Like Qualities (OLQs) by employing projective techniques.

The focus of present research was to isolate those factors that make an individual accident-prone, particularly as it appeared that psychological variables can predict accident proneness. Consequently, the study was designed with an aim to examine the relationship between selection variables involved in pilot selection and accident involvement. To ascertain this, it is hypothesized that there will be differences between pilots who have had accidents and those who are 'accident free' and that these differences can be explained by a group of underlying psychological antecedents namely, flying aptitude, intelligence and personality.

In this study, an attempt has been made to address three specific issues:-

(a) Whether the pilots engaged in accidents possessed a lower level of flying aptitude compared to those pilots who were not involved in any accidents? To study this, the scores and grades obtained on pilot aptitude battery at the time of selection were examined,

(b) Whether the pilots involved in accidents possessed lower levels of intelligence as compared to the ones not involved in any? To examine this, the OIR grades obtained by pilots involved in accidents and those not involved in accidents were analyzed

(c) Are there any differences in personality characteristics of these two groups that may show a bearing on susceptibility to 'pilot-error accidents? To ascertain this, the OLQs assessed at the time of selection were analysed. In the current study, the construct accident proneness was considered as involvement in even a single accident

Material and Methods

The study examined the selection and accident records spanning 24 years between 1973-1996 of 615 IAF pilots, about half of whom had clean records (accident free group = 333) while the other half had been involved in an accident due to pilot error (accident group = 282). The sample for accident-free group was drawn randomly by matching in terms of age and flying experience with accident-group. The sample sizes differed for each variable complete details for all cases were not available. Data was subjected to statistical analysis. The demographic details of the sample are given in Figure 1&2.

Results

The data was analyzed using parametric and non-parametric statistics and the results with regard to selection variables viz. PAB scores & grades, OIR grades, OLQs and accident proneness are furnished in the succeeding paragraphs.

PAB and Accident-proneness

The performance on PAB of accident and

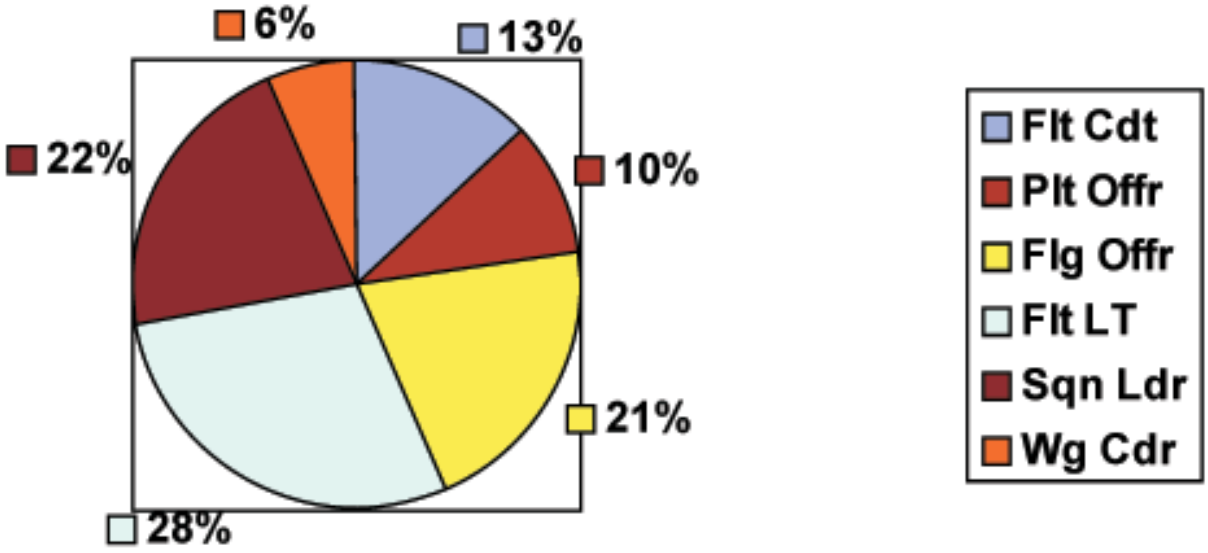

Figure 1: The rank wise distribution of accident group

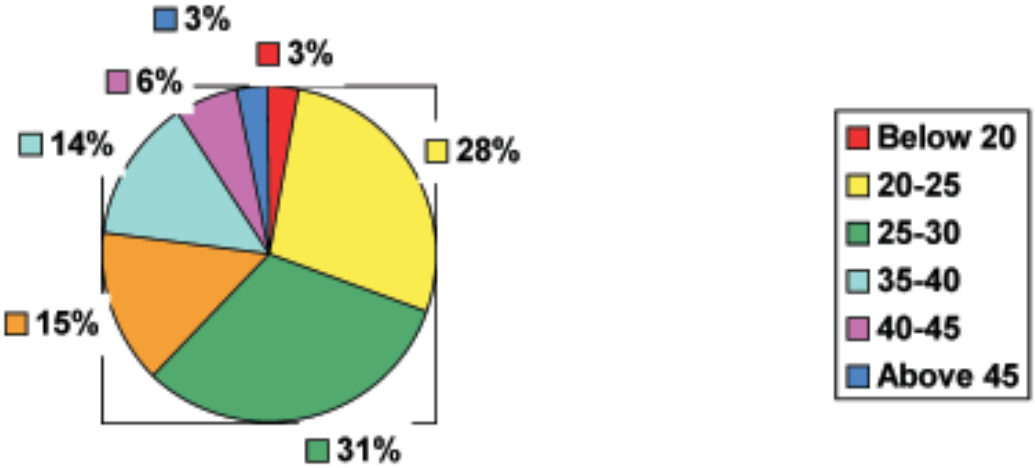

Figure 2: The age-wise distribution of accident group

Table 1: Descriptive statistics for accident and accident free group on PAB

Variable	Accident Group		Accident free Group		't' value
	Mean	SD	Mean	SD	
Flying Aptitude Scores	203.59	18.22 N=265	207.18 N=330	19.18	2.33 ($p<0.05$)

Table 2: Value of X^2 for PAB Grades of accident and accident -free group

Category	PAB Grade			
	I	II	III	Total
Accident Group	59(63.55)	101(110.28)	97(83.18)	257
Accident Free Group	77(72.45)	135(125.72)	81(94.82)	293
Total	136	236	178	550

df = 2

Chi-square $X^2 = 6.41$ ($p<0.05$)

accident free groups were analyzed. First, the mean domain scores for the groups "accident free" and "accident group" were computed and compared using't' test and the results are given in Table 1.

The chi-square value was also found to be significant at 5% level indicating significant differences in the accident rates of different grades with regard to accident and accident free groups. The results further illustrate that accident rates decreased with higher PAB grades thereby exhibiting inverse relationship between the performance on PAB and accident involvement.

OIR and Accident Proneness

Similar analysis using chi-square was carried out in respect of intelligence grades and accident involvement. The results are presented in Table 3.

The chi-square value was not found to be significant in the accident rates among various OIR grades with respect to accident and accident-free groups. Further analysis carried out among different grades of OIR also revealed non significant differences.

Table 3: Value of X^2 for intelligence grades of accident and accident -free group

Category	Intellegence Grades				
	I	II	III	IV	Total
Accident Group	30 (27.29)	88 (87.24)	67 (66.21)	02 (6.26)	187
Accident Free Group	31 (33.71)	107 (107.76)	81 (81.79)	12 (7.74)	231
Total	61	195	148	14	418

df = 3

Chi-square X^2 = 5.76 NS

Table 4: Mean, SD and 't' values for personality characteristics of accident and accident- free groups

Variable	Accident Group		Accident free Group		't' value
	Mean	SD	Mean	SD	
Personality Characteristics	287.71	44.00 n=333	288.91	41.07 n=237	0.33

Personality and Accident proneness

The mean domain scores for both "accident free" and "accident" groups on OLQs were computed and compared using't' test. The results are given in Table 4.

The table reveals that performance on personality tests of both these groups viz., accident (287.71) and accident-free (288.91) has largely remained the same as the difference was found to be non-significant.

Discussion

PAB and Accident-proneness

From the significant difference noticed between accident group and accident-free group on PAB (Table 1), it can be derived that pilots who were involved in accidents performed low, on the average, on PAB compared to the pilots of accident free group. It was further observed from the results (Table 2) that fliers securing Grade III and II on Flying Aptitude report significantly more accident-involvement than those in Grade I indicating thereby that high performance on Flying Aptitude were linked with low accident-involvement. These interpretations have empirical support from previous studies [13, 14].

OIR and Accident Proneness

The non- significant difference obtained between accident and accident- free groups with regard to intelligence and accident involvement (Table 3) indicates that intelligence and accident involvement were independent of each other. Therefore it is evident from the obtained results that accident involvement of pilots in the present study may not be due to their lower levels of intelligence.

Although the majority of investigators feel that this is the case, it might be mentioned that Barthe [23] has reported that accident- prone individuals seem to have an increased time for the duration of a given reaction. In a study by the Federal Aviation Administration determined that the predominant underlying cause of aviation accidents involved decisional problems or cognitive information processing [16]. However, according to Heinrich [24] less than 1% of all accidents may be attributed

to subnormal intelligence as determined by psychometric tests. Moreover, it has been determined by Smith and Greenwood [25] that neither slow reaction time, low intelligence, nor any other factor which can be determined by psychometric tests distinguishes accident-prone from other individuals.

Though the findings of the present study contribute to the literature in terms of establishing a non significant relation between intelligence and accident involvement, future research may be undertaken in view of the inconsistent findings in the literature regarding the relationship between these two variables for drawing definite inferences.

Personality and Accident proneness

The results obtained with respect to personality characteristics and accident proneness (Table 4) indicates that accident group and accident free group do not differ significantly in their performance on personality.

The findings reveal that there are no identifiable patterns of personality characteristics that set apart those having accidents from those who are not. A study by Sanders and Hofmann [21] using 16 PF could correctly classify 86% of the aviators for their previous pilot-error accident involvement. An attempt to cross-validate the findings reported in the original study however did not significantly discriminate the personality factors and the aviators' prior pilot error accident involvement [22].

The findings indicate that individual differences in personality characteristics of the aviators prevent consistent identification of traits associated with pilot-error groups. Though there are a number of studies on pilot personality, the debate on whether personality predicts accident proneness still exist. Current research did not support the hypothesis that the accidents will positively correlate with personality. The results do not in any way undermine the importance of personality characteristics for pilots because the emphasis in the present study was on specific issue of accident proneness. But when it comes to overall flying performance and adjustment, personality aspects may come into picture. Future research needs to substantiate the possible interactive effects of personality and accident involvement by studying individual personality characteristics.

Conclusion

It is important to understand the psychological characteristics of the accident-prone aviator, so that he/she can be recognized in advance as they are likely to pose a threat to flight safety. For this purpose, in the present study, the relationship between the selection variables employed for pilot selection and accident-involvement was analyzed with an aim to make better pilot-selection decisions.

From the evidence now at hand, it seems fairly certain that accident free group and accident group differed significantly on flying aptitude. Therefore, it can be concluded that individuals scoring high on PAB would fly safely many years, whereas the relatively low scorers have more probability of getting into air accidents. The decisive role therefore seems to lie in flying aptitude. This finding in a way dispel the notion, that the generation of aircraft that existed when current aptitude tests were first devised demanded highly developed psychomotor skills in their pilots and modern aircraft are more sophisticated technologically and draw more upon intellectual skills. It further suggests how greater attention to the flying aptitude of pilots may facilitate air safety by weeding out potentially risky individuals. The same can be achieved perhaps, by laying down stringent selection standards upon the performance by the candidates on aptitude battery.

Although findings of the present study are generally consistent with past research outcomes and intuition, there are some notable exceptions. Though flying aptitude was found related to accident proneness, it is not only the aptitude per se that is significant while ascertaining the suitability of a pilot. Due consideration should also be given to intelligence and personality of the individual at the time of selection since these aspects assume importance as pilots go up in the ladder and become responsible for decision making and well being of their men.

References

1. Li G, Baker SP, Lamb MW, Grabowski JG, Rebok GW. Human factors in aviation crashes involving older pilots. Aviat Space Environ Med 2002; 73(2):134-8.
2. Greenwood M, Woods HM. The incidence of individual accidents upon individuals with special reference to multiple accidents. London: Industrial Fatigue Research Board; 1919.
3. Greenwood M, Yule GU. An inquiry into the nature of frequency distributions representative of multiple happenings, with particular reference to the occurrence of multiple accidents or disease or repeated accidents. J Royal Stat Soc 1920; 83: 258.
4. Farmer E, Chambers. A study of personal qualities in accident proneness and proficiency. Report no. 55. London: Industrial Health Research Board Report. H. M. S. O; 1929.
5. McKenna FP. The human factor in driving accidents. An overview of approaches and problems. Ergonomics 1982; 25 (10): 867-78.
6. Lardent CL. Pilots who crash: Personality constructs underlying accident prone behaviour of fighter pilots. Multivariate Experimental Clinical Research 1991; 10(1): 1-25.
7. Haight FA. Accident proneness: The history of an idea. Irvene: Institute of Transportation studies; 2001.
8. Visser E, Pijl YJ, Stolk RP, Neeleman J, Rosmalen JG. Accident proneness, does it exist? A review and meta-analysis. Accid Anal Prev 2007; 39(3): 556-64.
9. Hilakivi I, Veilahti J, Asplund P, Sinivuo J, Lattinen, Koskenuvo K. (1989). A sixteen factor personality test for predicting automobile driving accidents of young drivers. Accid Anal Prev 1989; 21 (5): 413-8.
10. Arthur WA, Barrett GV, Doverspike D. Validation of information processing test battery for the prediction of handling accidents among petroleum-product transport drivers. Journal of Applied Psychology 1990; 75 (6): 621-8.
11. Biesheuvel S, White M. The human factor in flying accidents. South African Air Force J 1949; 1 (2).
12. Dunbar HF. Psychosomatic Diagnosis. New York: Paul B. Hoeber, Inc., 1943.
13. Souvestre PA, Landrock CK, Blaber AP. New paradigm for understanding in-flight decision making errors: a neuro-physiological model leveraging human factors. Hippokratia 2008; 12 Suppl 1:78-83.
14. Gaur D. Human Factors Analysis and Classifivation System applied to civil aircraft accidents in India. Aviat Space Environ Med 2005; 76: 501-5.
15. Kantor JE, Carretta TR. Aircrew selection systems. Aviat Space Environ Med 1988; 59:A32-8.
16. Adams RJ, Ericsson AE. Introduction to cognitive processes of expert pilots. Hum Perf Extrem Environ 2000; 5(1):44-62.
17. Patrick RV. When the engine goes "Bang"! 2006; Available at URL: http://www.aviationweek.com/aw/generic story_generic.jsp? channel=busav &id=news/accid0906.xml&headline=Accident-Prone%20Pilots. Accessed May 30, 2008
18. Ganesh A, Joseph C. Personality studies in aircrew: An overview. Indian Journal of Aerospace Medicine 2005; 49(1):54-62
19. Cooper CL. The stress of work: An overview. Aviat Space Environ Med 1985; 56 (7): 627-32.
20. Voge VM. Failing aviator syndrome: A case history. Aviat Space Environ Med 1989; 60 Suppl 7: A89-91.
21. Sanders MG, Hoffman MA. Personality aspects of involvement in pilot-error accidents. Aviat Space Environ Med 1975; 46(2):186-90.

22. Sanders MG, Hofmann MA, Neese TA. Cross-validation study of the personality aspects of involvement in pilot-error accidents. Aviat Space Environ Med 1976; 47(2):177-9.

23. Barthe R. Les facteurs de predisposition dans les accidents du travail. Presse Med. 1936; 46: 1619.

24. Heinrich HW, Petersen D, Roos N. Industrial accident prevention: A safety management approach. 5th Ed. New York: McGraw-Hill; 1980.

25. Smith M, Leipee, Greenwood. Sickness, absence and labor wastage. London: Med Research Council Indust; 1936.

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