Design, Fabrication and Utility of a Flight Oriented Performance Test

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Abstract

A new Flight Oriented Performance Test (FOPT) has been developed to determine decrement in performance under stresses like mild hypoxia, partial sleep deprivation, etc., commonly encountered by aircrew. It involves a complex psychomotor task with sensory inputs, visual and motor coordination, memory and reaction time as its components. In this test, the subejct has to make a presentation of a desired pattern of lights with coordinated controlled movements of hand and feet similar to controlling the position of an aircraft. Trials were conducted under mild hypoxia in a decompression chamber and under condition of partial sleep deprivation in a sleep laboratory. Decrement in performance under both the conditions was found to be highly significant.

Introduction

The need for a sensitive psychomotor performance test has been felt for a long time which should be useful for the following purposes

(a) To demonstrate to the aircrew and quantify the adverse effects of various stresses commonly encountered in flying, such as mild degree of hypoxia, partial deprivation of sleep, after effects of alcohol.

(b) To use it as a part of pilot aptitude battery of tests during selection.

Psychomotor performance requires sensory and cognitive functioning as well as a relatively large motor involvement. Flying involves complex psychomotor task[5] needing optimal efficiency and peak performance. The danger of decrement of such performance under various stresses associated with flying conditions could jeopardise flight safety. Various psychomotor tests have been designed to demonstrate and to measure the decrement in performance under different stresses. Moreover, candidates for flying training are given a battery of pilot's aptitude tests for selection which involve psychomotor performance and comprehension related to the basic requirements of flying. This helps in reducing the wastage rate at a later phase as training extends over long period and involves considerable expenditure. Thus there has been a need to evolve a more sensitive and valid test to identify individuals or groups with aptitude for flying.

Keeping these objectives in view a new Flight Oriented Performance Test has been designed and fabricated at the Institute of Aviation Medicine, Bangalore.

FOPT System

The test combines two types of psychomotor tasks (a) the measurement of general speed or

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response involving a motor component and (*b*) a complex motor response. It has been established that psychomotor performance includes a factor known as 'general psychomotor speed factor.'[2] As this factor is of importance in flying, the same has been included in the present test.

The test designed at IAM involves careful visual observations, judgement, memory, reaction time and motor coordination as its components. Its operation is flight oriented resembling the pilot's task in controlling the position of an aircraft. It is an objective test of short duration and needs little practice for learning. It closely fulfils the criteria, formulated by Billings[1] for short term testing.

The apparatus has a front display panel consisting of three sets of double rows of lights representing pitch, roll and yaw movements. The movement in each axis is given in eight point discrimination which is shown in Figure 1.

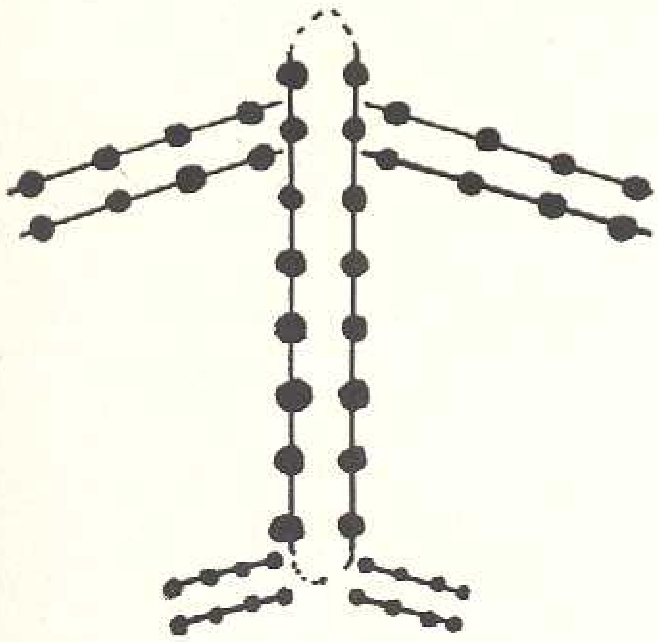

Fig. 1

The set-up is shown in Figure 2. The subject sits on a chair at a distance of 2 feet from the panel. He holds a control column, linked with the floor board, which can be moved in two directions, i.e. fore-and-aft and side-to-side. He places his feet on a pair of rudder pedals which move differentially

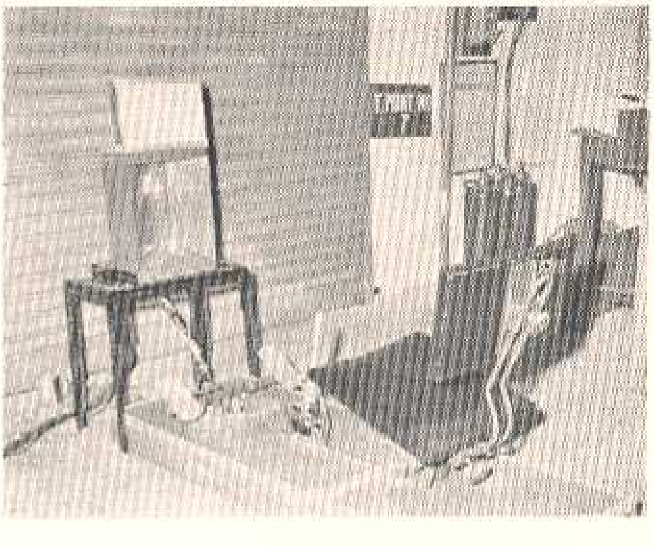

Fig. 2

forward and backward resulting in a rotational movement along a vertical axis.

One row of lights is activated by the controller through a programme control. Alternately, the position is shown by a 3-digit number on a screen located on top of the light display. The first, second and third digits show the positions in pitch, roll and yaw axes respectively. These two methods of presentations can be used separately or simultaneously.

The position display on the panel or the screen switches off after 2 seconds and the subject has to remember the display. He then matches the position by simultaneous and co-ordinated control of stick and rudder and presses a switch indicating completion of task. A chronoscope included in the circuit automatically records the time taken for each cycle. Failure to match properly is recorded as error. A fresh position is then displayed. A total of 20 such combinations are displayed during one test. A block diagram depicting the sequence of test is shown in Figure 3.

Reliability of the Test

Reliability here refers to the consistency of the test under the same condition. The usual method of calculating the reliability co-efficient is the test

INSTRUMENTATION

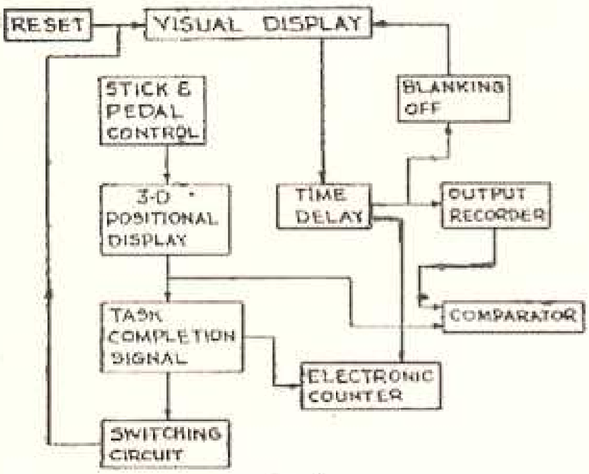

Fig. 3

and retest method. This method could not be employed in this test due to difficulties in getting the same subjects over a long period for retesting. Each item in this test is a discrete entity as such the test is more of a power test, although time is taken as a variable. Hence the reliability co-efficient has been calculated with the use of split half method. The test was divided into two halves of ten items each. Items with odd serial numbers formed one group and those with even numbers the other group. The reliability co-efficient calculated for these two groups was found to be 0.78 which is satisfactory.

Validity of the Test

Validity of a test can be measured in many ways. One way is to match the success in a test with the success in the actual field for which the test was fabricated. Another way is to match the score in a test against a score of an already valid test. A third method is to find out the variability of scores among different criterion groups. In this test the last method has been employed when three groups have been compared *i.e.* fighter pilots, transport pilots and non-fliers. The test was administered to 54 fighter pilots, 44 transport pilots an 98 non-fliers. The results are shown in the table I.

Table I

Test Scores

Groups	*Number*	*Mean score in (in seconds)*
Fighter pilots	54	7.2
Transport pilots	44	9.1
Non-fliers	98	11.3

The differences in mean score on this test between the fighter pilots and transport pilots, between the fighter pilots and non-fliers, and between the transport pilots and non-fliers were found to be significant ($P < 0.001$, in all the cases), with the fighter group taking lesser time compared to the other groups. This shows that the test is capable of differentiating fliers from the non-fliers and among the fliers, between fighter and transport pilots.

Utility of the Test

This test has been found to be very sensitive in demonstrating the deleterious effects of mild hypoxia on the performance of an individual on this test. The study under mild hypoxia was carried out in the decompression chamber and 15 subjects formed the sample. These subjects were administered the test in an altitude chamber at ground level and again after 45 minutes of stay at 15000 feet of simulated altitude while breathing air. The results are given in Table II.

Table II

Test Scores under Mild Hypoxia

Number of subjects	Mean score (in sec) at ground level	Mean score (in sec) at 15000 ft
15	5.96	6.88

Difference in means = 0.92 ($0.0001 < P < 0.01$)

The results which are statistically significant show that this test is sensitive enough to show the deleterious effects of mild hypoxia. Earlier studies under simulated conditions on various psychological tests[5] and Critical Fusion Frequency Test[4] carried out at this Institute in the Depeartment of Neuropsychiatry showed results which were found to be "not significant."

Further, this test has also been used in a study where the effects of partial sleep deprivation for three nights and days on behaviour and task performance were studied. 10 subjects were taken up for this study. They were allowed only four hours of sleep each night for three successive nights and the test was administered. They were not allowed to sleep during day time. The results are shown in Table III.

TABLE III

Mean Score (in seconds) before and after sleep deprivation and the significance of their differences

No. of Subjects	Basal	1st Morning ASD	2nd Morning ASD	3rd Morning ASD	Mean differences between		
					B & 1st Morning	B & 2nd Morning	B & 3rd Morning
10	4.7	5.6	5.5	5.5	+0.9**	+0.8**	+0.8*

+ = Deterioration
ASD — After Sleep Deprivation, B = Basal

** Significant at P — 0.01
* Significant at P = 0.05

The results in Table III show that deterioration of performance on this test after partial sleep deprivation was statistically significant. The studies are on record where deleterious effects of sleep deprivation could not be demonstrated as these tests were not sensitive enough to show the deterioration.[7,8] Thus it is seen that this test is sensitive enough to demonstrate the deleterious effects of partial sleep deprivation.

ACKNOWLEDGEMENT

We are thankful to Air Officer Commanding IAM, Air Cmde JS Sant, for giving encouragement in writing this paper.

Our thanks are due to technical staff of this Institute who helped in the fabrication of the test.

We also thank Miss K Prabha, SSA, Cpl Sharma, BR, Med/Asst, AC Mali, Med/Asst for their technical help. Mr PLN Rao Statistician for statistical work and Mrs V Chidambaram for typing this paper.

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