Spatial Orientation Test: Its use in Aviation

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Abstract

A SPATIAL Orientation Test (SOT) has been fabricated to assess the ability of a subject to orientate in space. A subject is presented with a number of diagrams of aircraft in different attitudes in rapid succession. The wing tips of the aircraft are coloured red in one and green in the other. A colour code of red and green is also presented with each diagram. The colour code is compared with the wing tips to determine the orientation of the aircraft in the diagrams. The test is conducted very fast and the judgement depends upon the memory, visual imagery and discriminative ability. The test has been found to discriminate between fliers and non-fliers and to be of help in the assessment of the effects of sleep deprivation and head injuries.

Introduction

Spatial orientation in flying context is often referred as the correct knowledge or impression of one's position with reference to the surface of the earth[1]. To say that this ability to orient oneself in space is vital for a pilot is an understatement, for often his life and the success of the mission depend on it. For orientation purposes the fliers mostly depend on visual cues. In bad weather these cues become undependable and the pilot is likely to get disoriented. Again, when the pilot is under stress like fatigue or sleep deprivation, ability to orient in space is likely to get adversely affected.

Although there has not been any dispute about the relative requirement of this ability in a flier, for a long time no single test was available to assess this composite ability, much less to study the effects of different stresses on it. It is true, certain components of this ability like memory, visual imagery, and ability for discrimination are involved in certain other tests that are currently in use. However, for any meaningful study on the ability of spatial orientation a composite test like the one under discussion was required. Hence the Spatial Orientation Test (SOT) was fabricated at the Institute of Aviation Medicine, Bangalore.

The test

SOT consists of 32 stimulus pictures in slide form (Fig. 1), a 35 mm slide projector, and an automatic timer unit that changes the slides at stipulated time intervals.

Each stimulus picture depicts the diagram of an aircraft either nose down or nose up. Further two views of the aircraft i.e. "view cockpit" (top view of the aircraft) and "view underside" (view from below the belly of the aircraft) are also shown. Thus four sets of diagrams are available. They are :

(*a*) Nose up—view cockpit
(*b*) Nose up—view underside
(*c*) Nose down—view cockpit
(*d*) Nose down—view underside

The "view cockpit" is recognised by the straight and angled lines employed in the drawing and the "view underside", by the four gun points at the nose end of the fuselage.

The wing tips of the aircraft are coloured red and green, one colour on each wing tip. Down

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below the diagram of the aircraft is given a colour strip which is divided into three sections. The strip contains red and green colours and they are distributed into the three sections in the order, red-green-red or green-red-green (Fig. 1).

For the test, the above slides are projected on a screen with the help of a 35 mm slide projector. The timer unit attached to the projector, changes the slides at the time intervals the experimenter selects. The time intervals ranging from 1 second to 30 seconds can be selected by adjusting the selector switch of the timer.

Administration of the Test

The subject is seated behind the projector facing the projection screen. After projecting one

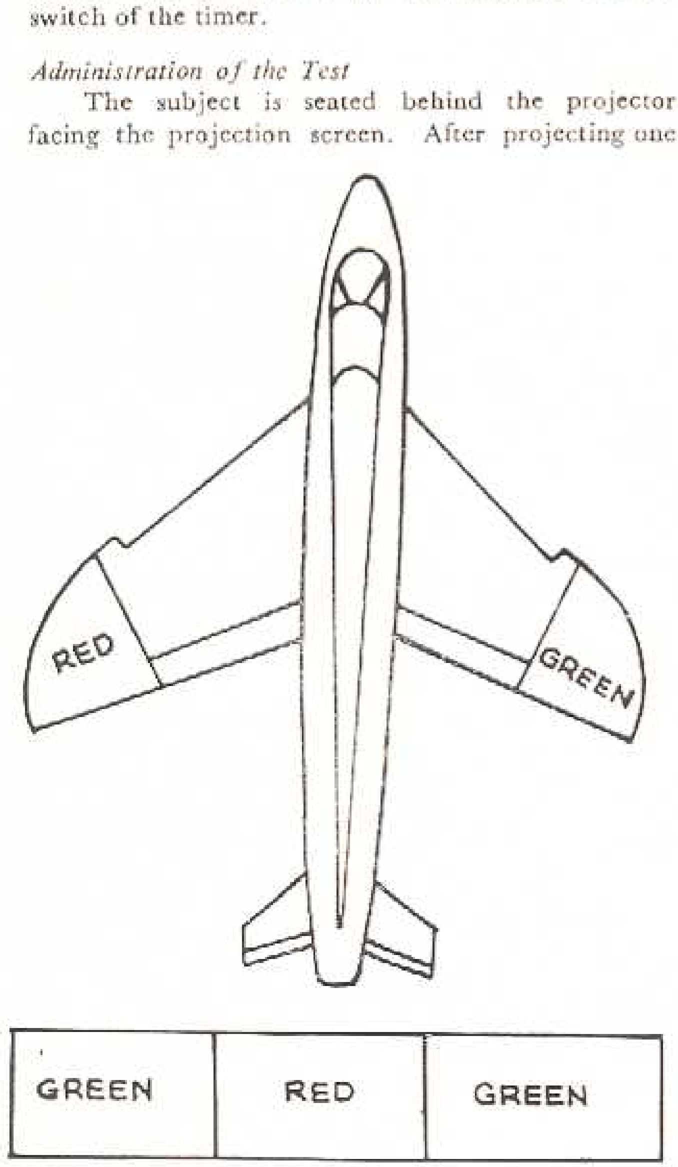

Fig. 1
A stimulus picture depicting diagram of an aircraft in nose-up position top view. Wing tips are marked colour 'RED' and 'GREEN.' A colour code 'GREEN-RED-GREEN' is shown at the base of the picture for matching.

slide on the screen, the subject is given the necessa instructions regarding the nature of the task and t way to proceed with the test. His task is to imagi himself to be in the cockpit, to note what the centr section colour of the colour strip is, and to tell t experimenter that this colour is either on the st board wing tip or on the port wing tip of the aircra For the correct answer to be obtained quickly, is to proceed in the sequence (a) the central secti colour, (b) the view of the aircraft, (i.e. view cock or view underside) and (c) to match the centr colour with the wing tip colour. In addition to t first slide, three more slides are presented to the su ject, so that he gets familiarised with the salie aspects of the diagrams and the procedure of taki the test. If the subject is not yet fully satisfied wi his ability to proceed with the test he would be show the same four slides again. After he understan the test he is told that 16 more slides would presented to him in rapid succession, the tim interval between the presentations being 3 seconds. certain cases where the subjects cannot cope up wi this speed, a 5 second interval between two present tions is adopted. This time interval includes t time taken for the change over of the slide in additi to the actual presence of the image on the scree Therefore the subject is free to give his answer, util ing his visual imagery, even after the picture has d appeared, but not after the next diagram is presente The subject is further instructed to do the test a fast clip and he is reminded that even if he happe to miss one or two answers in between, it should n push him off balance, and continue the test in a co manner, because he is free to start afresh from t picture before him, forgetting the previous 'wron ones.

During the test, while the diagrams are bei presented, the subject keeps on speaking out t answers and the experimenter notes them down the answer sheet. Although there are 32 slides total, in the general protocol of the experimen conducted at IAM, 20 slides are presented, of whi the first four are taken as practice trials, the re being counted for the experiment.

Scoring

Scoring is done utilising either of the followi methods :

(a) Calculating the proportion of successful re ponses from the total number of stimul pictures presented.

(b) Noting the total number of correct responses.

Validity of the test

If a test discriminates between known criterion groups, to that extent, that test is valid. SOT was administered to 3 criterion groups viz., fighter pilots, transport pilots and nonfliers and the data are shown in Table I.

TABLE I

SOT—Correct Response

Groups	Number	Mean Correct Response	s.d.
Fighter (F)	31	12.5	2.5
Transport (T)	27	10.5	2.5
Non Flier (NF)	36	8.0	3.0

Mean difference between		Level of Significance
F and T	-2.0	$p < 0.01$
F and NF	-4.5	$p < 0.001$
T and NF	-2.5	$p < 0.001$

From the above table it is evident that the flier group as a whole performed better than the nonfliers. At the same time, among fliers, fighter pilots' performance was significantly better than that of the transport pilots. It is not intended to hazard any hypothesis about how this difference in performance among different groups has come about. The point to note is that the test differentiates between known criterion groups.

This is a speed test and the difficult items are evenly distributed. It appears that learning has an effect on the performance of this test. The orientation aptitude develops through a learning process as has been postulated by some[5]. The performance score on this test then becomes a score of an achievement test unlike a score obtained from say a test of Abstract Reasoning or Mechanical Aptitude. In that case, computation of a reliability coefficient is not much of a necessity. The important point to note is whether the test is valid or not.

Utility of the Test

This test was used in a study where the effects of partial sleep deprivation on task performance and behaviour were assessed[3]. Ten subjects were partially deprived of sleep for 3 successive days and nights. They were allowed to sleep only 4 hours every night and no sleep during day time. Their basal score on the test, scores of each morning after partial sleep deprivation and the score of the morning after recovery sleep were obtained. The results are shown in Table II.

TABLE II

SOT – Proportion of success – Mean value, differences at different stages after sleep deprivation (ASD) and their significance.

	Basal	I morning ASD	II morning ASD	III morning ASD	Post recovery sleep
Mean	0.99	0.91	0.92	0.93	0.94
Difference from basal		-0.05	-0.07	-0.06	0.00
Significance		$p<0.05$	$p<0.05$	$p<0.05$	—

The proportion of success on each morning after sleep deprivation is lower than the basal score. This difference is significant at 5% level. No difference was found between scores after the recovery sleep and the basal. This proves to a great extent that the functions involved in the test tend to get deteriorated, on exposure to a stress like partial sleep deprivation. In another study of partial sleep deprivation where the test was used, similar trends were noticed[2].

Another study that employed this test was the evaluation of head injury cases with flight oriented performance tests[4]. In this study, 48 head injury cases were assessed on a battery of psychological and psychomotor tests in conjunction with neurological and clinical assessments. Performance of the above head injury cases was studied in comparison with that of comparable normal group. Spatial Orientation Test data pertaining to 38 head injury cases were compared against 37 normal subjects. As the test was believed to be discriminating between fliers, and non-fliers the analysis was carried out separately for both these groups. The results are shown in Table III. It is seen from the above table that the normal group performed better than the head injury group among both fliers and non fliers. The mean differences are statistically significant for both the groups.

TABLE III

SOT—Proportion of success—Normal versus Head Injury Group (HIG)

	Fliers		Non fliers	
	Normal	HIG	Normal	HIG
Number	19	21	18	17
Mean	0.85	0.71	0.74	0.48
s.d.	0.15	0.17	0.21	0.10
Mean difference between normal and HIG	0.14		0.26	
Level of significance	$p < 0.01$		$p < 0.001$	

It has been said earlier that the test discriminates between the criterion groups and this is despite the intervening process of learning. Although learning plays a role in the development of spatial orientation aptitude, there could be inherited individual differences[6]. This is quite true for the learning ability itself. A selection procedure hinges on the premise that individuals differ. In that case it would be worthwhile if the SOT is administered to candidates at selection stage, as it will throw some light on flying success vis-a-vis spatial orientation aptitude as indicated by SOT. Efforts are already in progress at least, tangentially, with regard to the feasibility of this proposition. At present this test is being administered to NDA candidates reporting for medical evaluation at IAM. These cases will be followed up at a later stage.

Spatial orientation test keeps the sustained attention of the subject. To most of them, it is a novel type of test. In other words, it has adequate face validity that motivates the subject to do his best. It is simple to administer and the testing procedure is of very short duration.

Conclusion

A spatial orientation test has been fabricated to test individual's performance involving memory, visual imagery and ability to discriminate spatial orientation of aircraft position.

(a) The test has fair degree of validity.

(b) The test is sensitive enough to bring out the deleterious effects of partial sleep deprivation on performance.

(c) The spatial orientation test is useful in discriminating the head injury group from the normal group.

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