

Original Article

Temporal changes in visuo-spatial abilities amongst flying trainees

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Computerized Cognitive Test Battery (CCTB) evolved by the author has been extensively used for objective evaluation of cognitive abilities pertinent to flying environment. In this study these abilities were assessed in 265 candidates at Air Force Selection Board and 145 stage I trainees and 102 stage II trainees at various flying training establishments. Out of these 42 flying trainees were common between stage I and II. The CCTB was administered on completion of 6 months and one year of training respectively in them. It was revealed that there was a significant improvement in various attributes. Mental rotation improved from 72.02 to 92.49 (+ 15.46), Dual Performance showed improvement of 9.18 and 8.83% for letter and digit matching tasks respectively. There was a reduction in 3.9% in impulsivity and almost 100% increase in Latent Coordination Time (0.38 Secs to 0.69 Secs) which shows that flying training introduces the habit of more deliberate decisions. There was also a highly significant improvement in speed of perception (From 27.55 to 13.59 msec +13.95). Visual Imagery also showed significant improvement scores in large number of subjects at AFSB and FTE's will also be presented to show the gradient of changes in the scores. In conclusion the results show that CCTB is a reliable and valid tool for assessment of visuo - spatial abilities.

Keywords: Visuo spatial ability, Aircrew selection, flying training

Indian Air Force uses a rather obsolete version of a battery of perceptual - motor tests in its PABT (Pilot Aptitude Test Battery). It is being realized that ecological validity of test batteries in the context of present day cockpit, would need addition of some novel cognitive concepts in their construction. No serious work has taken place in the direction of revising our own pilot selection methods.

There is a need to improve the selection of military aviation applicants in consonance with recent advances and innovations in computer technology and psychological theory/measurement. New emphasis is responsible for use of computer based

performance tasks in place of paper and pencil tests. USAF [1-4], Royal Navy [5] and New Zealand Air Force [6] have carried out a large scale effort to determine the validity of computer based test battery for pilot selection and classification. Dolgin and Gibb [7] have reviewed literature on mental abilities, attitudes and personality characteristics of aviators. 13 predominately perceptual - motor performance tests were incorporated in USAF BAT (Basic Attributes Test Battery) for fighter pilot selection. Kelly [8] has concluded that USAF is not able to obtain objective evaluation of its pilots.

Literature search on the cognitive abilities for flying has shown that speed of

perception [9-11], visual imagery [12-15], mental rotation [16] and dual performance [17-18] are important variables for flying. We have carried out work on the perceptuo-cognitive abilities [19] and personality profile [20] of ab-initio flying trainees. Later we conducted field trials on one of the tests of mental rotation vis-a-vis performance in flying and found its usefulness in assessment of cognitive abilities for flying [21].

Our present work involves extensive mid course assessment of cognitive attributes of flying trainees with the help of Computerized Cognitive Test Battery devised by us. The inputs from this study are intended to be used for categorization of flying trainees as well as evolve standards for initial screening of flying trainees for selection. In this study we are reporting the details of temporal changes in cognitive scores in 42 flying trainees who underwent this procedure during stage I and stage II flying training.

Material and methods

Computerized Cognitive Tests

Inspection Time - This is a test for finding out speed of perception of small detail. We get two lines of different size on the screen, which are replaced by thick solid lines after a programmed period of exposure. The lines appear for 200 ms initially and the time of exposure is reduced to 1 ms in gradual stepladder fashion. The threshold of perception in terms of exposure is called inspection time.

Visual Imagery and Visuo-Motor Coordination - This test finds out the limit of visual imagery in terms of short-term storage of common objects. The objects

come on the screen at random location on an imagery circle. The subject has to memorize the location of the objects on the screen and reproduce the same after a brief exposure. The latent and movement time for each screen along with the correctness of the response is given after each trial. Final score on number of images correctly replaced along with the period of exposure indicates the maximum tolerance of the subject.

Mental Rotation: This test is done with the help of Flags. The computer screen shows two flags. One on right top shows the flag in normal upright orientation and the other flag in the center is the rotated version of the reference flag. The reference flag is rotated as it is or reversed and rotated. The subject has to decide whether it is the same side rotation or is it a reverse side rotation.

Dual performance test: This test measures the ability to carry out two tasks concurrently. The subject is to press one key at rhythmic intervals. Concurrently he is required to maintain vigilance on two circles located on the left and right top of the screen with six letters and digits each. Scores are obtained for matching accuracy for letters, digits as well as for keeping the rhythmic key presses closer to the central line.

Subjects

The study has been conducted in a phased manner. After initial development of the test battery, it has been administered to pilot candidates in the National Defence Academy entry as well as Stage I and Stage II flying trainees.

- (a) 265 candidates reporting to National Air Force Selection Board from February to April 1996 were

- administered
(b) 42 subjects
trainees
in New
(c) 205 subjects
(n = 42)
flying
batteries
included
part in

Methodology

All the 4 tests were administered in the uniform instructional format with minimal explanation. The conduct of the test took about 35-40 minutes.

1.	IT
2.	VIT
3.	LT_M
4.	LT_SD
5.	MT_M
6.	MT_SD
7.	MRT
8.	IMP
9.	LMS
10.	DMS
11.	TP_M
12.	TP_SD

IT	=	Inspection Time
LT_M	=	Latent Time - Mental
MT_M	=	Movement Time - Mental
MRT	=	Mental Rotation Test
LMS	=	Letter Matching Score
TP_M	=	Two Performance - Mental

random location on the screen. The subject has to identify the objects on the screen. The objects are the same after a brief movement time for the subject to indicate the correctness of the response. Final score is the number of objects correctly replaced. The exposure indicates the level of the subject.

The test is done with the help of a computer. The outer screen shows the flag in the top and the other flag in the bottom. The reference flag is rotated and the subject has to rotate the flag. The subject has to indicate if it is the same side or opposite side rotation.

This test measures the subject's ability to perform two tasks simultaneously. The subject has to press one key to rotate the flag. Concurrently he is to identify the objects on two circles at the top of the screen. The subject has to indicate the accuracy for letters. The subject has to keep the rhythmic pattern of the central line.

The test was conducted in a phased manner. The development of the test was administered to pilot trainees of the Indian Defence Academy and Stage II flying trainees.

The results reported to No 2 Selection Board from April 1996 were

administered the test battery.

- (b) 42 subjects undergoing Stage I training participated in this study in Nov 1995.
- (c) 205 subjects undergoing Stage I (n = 103) and Stage II (n = 102) flying were administered the test battery in April/May 1996 which included the 42 subjects who took part in this study in Nov. 1995.

Methodology

All the 4 tests described above were administered in the same order. Each test had uniform instructions on the screen and minimal explanation was required in the conduct of the trials. Each candidate took about 35-40 minutes in the completion of

the tests.

Results and discussion

Table I provides comparative analysis of visuo spatial abilities in respect of 42 trainees who were administered the test battery in both Stage I and Stage II training. This shows that Mental Rotation and Dual Performance Tests showed maximum improvement along with the scores on Inspection Time. The latent time increased and impulsivity reduced significantly. This shows that flying training resulted in more deliberate decision making. The improvement in visual imagery was not statistically significant. In addition there was no significant change in time perception and movement time.

Table I : Temporal Changes in Visuospatial Abilities (N = 42)

		Stage I Sign (p)		Stage II		Diff	Value	Mean
		Mean	SD	Mean	SD			
1.	IT	7.55	22.05	13.59	20.27	13.95	4.15	0.000
2.	VIT	57.98	8.01	60.45	7.17	-2.48	-1.71	NS
3.	LT_M	0.38	0.20	0.69	0.25	-0.31	-7.27	0.000
4.	LT_SD	0.41	0.31	0.46	0.53	-0.05	-0.50	NS
5.	MT_M	2.28	0.87	2.11	1.09	0.17	0.99	NS
6.	MT_SD	0.89	0.45	0.93	0.86	-0.04	0.26	NS
7.	MRT	77.02	24.62	92.49	24.16	-15.46	-6.47	0.000
8.	IMP	13.73	8.86	9.83	6.63	3.90	4.36	0.000
9.	LMS	57.32	18.06	56.49	17.31	-9.18	-2.98	0.005
10.	DMS	63.98	13.98	72.81	13.69	-8.83	-3.30	0.003
11.	TP_M	3.63	0.53	3.70	0.56	-0.07	-0.82	NS
12.	TP_SD	0.92	0.35	0.87	0.28	0.40	0.67	NS

IT	=	Inspection Time	VIT	=	Visual Imagery Test
LT_M	=	Mean of Latent Time	LT_SD	=	SD of Latent Time
MT_M	=	Mean of Movement Time	MT_SD	=	SD of Movement Time
MRT	=	Mental Rotation Test	IMP	=	Impulsivity
LMS	=	Letter Matching Score	DMS	=	Digit Matching Score
TP_M	=	Mean of Time Perception	TP_SD	=	SD of TP

Table II : Percentile Values : Mental Rotation Test

%	Test		
	2 AFSB (n = 226)	Stage I (n = 145)	Stage II (n = 102)
1	14.8	26.6	37.7
5	34.6	40.5	48.0
10	40.5	46.0	53.0
15	44.5	49.9	55.2
20	48.5	55.3	60.3
25	42.7	59.9	63.5
30	54.5	60.3	67.9
35	58.5	64.5	74.5
40	51	69.2	77.2
45	64.5	71.8	82.8
50	68.5	75.5	86.5
55	70.5	80.8	88.6
60	75.5	83.5	92.0
65	81.9	86.3	98.0
70	84.1	90	104.0
75	88.7	93.7	106.6
80	94.4	98.4	111
85	98.5	109.1	115
90	104.5	110.5	120.6
95	115.5	116.5	123.0
99	124.5	126.9	130.8

Table II and III provide percentile values of the selected cognitive variable in AFSB candidates, Stage I trainees as well as stage II trainees. The percentile values are also presented in graphical form in Fig 1, 2 and 3 for visual imagery, mental rotation

Table III : Percentile Values : Dual Performance Test

%	Performance Test					
	2 AFSB (N = 266)		Stage I (N = 145)		Stage II (N = 102)	
	LMS	DMS	LMS	DMS	LMS	DMS
1	0.41	3.8	13.3	22.2	7.4	4.2
5	14.5	13.0	31.9	37.3	40.9	
10	19.9	22.2	36.1	42.3	42.0	49.0
15	23.2	31.9	39.8	49.0	47.1	52.5
20	27.9	36.5	42.6	52.0	48.6	55.1
25	31.8	39.1	46.4	53.7	50.3	59.1
30	35.5	41.6	49.5	57.9	53.4	62.6
35	37.8	45.5	52.0	59.2	57.1	64.4
40	42.6	47.9	55.7	61.0	59.2	67.4
45	46.1	50.9	58.2	62.9	60.5	69.9
50	50.2	53.4	61.0	64.0	63.6	70.9
55	50.3	55.6	62.9	66.0	67.2	72.2
60	57.1	58.6	64.9	67.9	67.8	72.4
65	59.8	61.3	66.3	69.5	69.2	75.6
70	53.2	64.3	68.5	71.4	70.9	76.6
75	55.2	66.4	70.2	74.0	72.8	78.7
80	69.3	69.7	73.1	76.7	76.4	80.4
85	74.8	72.5	78.8	79.3	81.6	84.2
90	79.9	78.8	82.3	81.2	85.1	89.8
95	83.8	83.8	85.8	84.7	91.6	92.1
99	93.4	93.0	92.3	94.9	98.2	92.1

and dual performance. The data show that there is consistent gradient of improvement in the performance from selection to completion of flying training in mental rotation and dual performance whereas the improvement is not consistent in the case

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Table Values : Dual Test

	Stage II (N = 102)		
	LMS	DMS	
22.2	7.4	4.2	
27.3	40.9		
32.3	42.0	49.0	
39.0	47.1	52.5	
52.0	48.6	55.1	
53.7	50.3	59.1	
57.9	53.4	62.6	
59.2	57.1	64.4	
61.0	59.2	67.4	
62.9	60.5	69.9	
64.0	63.6	70.9	
66.0	67.2	72.2	
67.9	67.8	72.6	
69.5	69.2	75.6	
71.4	70.9	76.6	
74.0	72.8	79.7	
76.7	76.4	80.4	
79.3	81.6	84.2	
81.2	85.1	89.8	
84.7	91.6	92.1	
94.9	98.2	92.8	

The data show that there is a significant improvement in scores from selection to training in mental rotation test whereas the improvement is not consistent in the case of

scores on visual imagery. This gradient is seen across the board in Mental Rotation Test but only in lower score range in the case of Dual Performance Test scores.

The analysis of this data shows that a score of 70 in Stage II trainees corresponds to 32 percentile in case of mental rotation test. Further score of 40 on LMS and 50 on DMS corresponds to 9th and 11th percentile values respectively. These values provide pragmatic cut off levels for categorization of trainees in to fighter and non fighter streams.

Conclusions and Recommendations

The cognitive test battery has adequate validity for pilot evaluation. The results of Mental Rotation Test and Dual Performance Test in this battery can be used for laying down norms for pilot selection as well as operational classification.

There is a need to follow up performance of pilots in fighter stream for a period of 2 to 3 years particularly the ones who are found to have lower visuo spatial abilities.

This study should be continued for 2 to 3 courses in all Flying Training Establishments so that hypothesis evolved in this study is tested on a larger sample.

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