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IQ Measures on the Wechsler Abbreviated Scale of Intelligence in Indian Air Force Aviators

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Higher intellectual functioning is linked to successful military flying and mission accomplishment in pilots. The use of intelligence test batteries and cognitive batteries also forms an integral part of testing to assess the intellectual abilities and memory performance of potential astronaut candidates. The objective of the present study was to assess the verbal, performance and full scale IQs in medically fit Indian military aviators. The Wechsler Abbreviated Scale of Intelligence test battery was administered to 50 healthy aircrew in an initial effort to establish baseline data for intellectual abilities in this population. The mean (SD) Verbal IQ of the group was 110.26 (7.84), the mean Performance IQ of the aircrew was 115.38 (7.10), and the mean Full Scale IQ was 114.26 (6.37). There were no significant differences of intellectual abilities based on demographic characteristics. There was a positive correlation between Verbal IQ, Performance IQ and Full Scale IQ scores. There were no significant correlations between verbal subtests. Data obtained in medical evaluation of grounded pilots can be compared with these normal aircrew and it can also be used as reference data in astronaut crews' selection and screening process.

Keywords: verbal and performance IQ, Indian military aviators

Intelligence tests have always played a significant role in the selection of military aviators. In general, flight tasks involve highly developed visuo-motor, visuo-spatial, and visuo perceptual skills. Each of these functions is adequately tapped by performance subtests of intelligence and is used as one of the measures of flying aptitude in military aviators' selection procedure. Intellectual abilities and memory performance are also included as part of operational aptitudes in the selection of astronauts where screening and evaluation of astronaut candidates usually include measures of cognitive and intellectual capacity.

The suspicion of decreasing intellectual capabilities of an aviator or presence of specific neurologically compromising conditions would necessitate assessment of the aviator's cognitive functions. In order to properly evaluate an aviator's intellectual functioning; the neuropsychologist and aviation psychologist should have knowledge of what constitutes normal functioning for this particular population. It may not be reasonable to assume that the specific absence of brain impairment according to normative data for the population at large is equally applicable to a population of aviators. An aviator population may require stricter limits than the general population (Guilmette & Treanor, 1986).

The nature and composition of space missions and crews have increased the importance of psychological issues which have become critical in operational space flight. It is increasingly important to select candidates on the basis of positive psychological characteristics. The objectives of selection strategies are twofold: to eliminate unfit or potentially unfit applicants and to select from otherwise qualified candidates those who will perform and cope optimally based on their basic operational aptitudes (such as intelligence), personality

characteristics, and attitudes. Intellectual abilities and memory performance of astronauts in critical situations are factors which will determine the success of the space mission.

Intelligence is an umbrella term describing a property of the mind comprehending related abilities, such as the capacities for abstract thought, reasoning, planning and problem solving, the use of language, and to learn. The concept of intelligence has been a hotly debated topic since the turn of the century. Wechsler took a more ecological approach and conceived of intelligence as a multidimensional construct, one that manifests itself in many forms. Wechsler believed that intelligence should be measured by both verbal and performance tasks, each of which measured ability in a different way and which could be aggravated to form a general, global construct (Wechsler, 1975).

Recent advances in psychological testing allow for thorough, broad-based assessment of intellectual, personality, and psychopathological domains via brief, reliable, and valid instruments (Retzlaff & Gibertini, 1988). Psychologists earlier used different objective instruments like Multidimensional Aptitude Battery (Retzlaff & Gibertini, 1988; Kratz, Poppen, & Lisa, 2007; Orme, Ree, & Rioux, 2000; Bishop, Faulk & Santy,1996), Wechsler Adult Intelligence Scale (Bishop, Faulk & Santy,1996; Fine & Hartman,1968; Santy, 1994), Wechsler Adult Intelligence Scale – Revised(Bishop, Faulk & Santy,1996; Santy, 1994; Guilmette & Treanor, 1986), and Wechsler Adult Intelligence Scale – III (Kratz, Poppen, & Lisa, 2007) to assess the intellectual abilities of the aviators and astronaut candidates. In all these studies, aviator groups' mean intellectual abilities were in the high average level compared to standardized population.

The purpose of this study was to begin establishing group data of military aviators performance on standardized intelligence tests. With normative data from this group it will be possible to more accurately determine the level of intellectual functioning, and possible impairment of military aviators whose level of cognitive functioning is in question. This baseline data of military aviators helps both in astronaut crew selection and screening process as well as the medical evaluation of the grounded pilots who have psychological/neurological deficits.

Method

Sample:

A group of 50 male active duty IAF aircrew, who had visited the Institute of Aerospace Medicine, IAF, Bangalore for OPTRAM (Operational Training in Aerospace Medicine), from June 10 to Aug 10 constituted the sample population. The selected subjects were fully fit medically, so that the intelligence test scores may be uninfluenced by any psychopathology. All subjects were volunteers. They were middle aged (mean age=26.44, SD=4.53), experienced in job (mean=4.38, SD=4.72) and flying hours (mean=855.82, SD=1113.94).

Tool:

The Wechsler Abbreviated Scale of Intelligence (WASI) (Wechsler1999) was developed to meet the demands for a short and reliable measure of intelligence in clinical, psycho-educational, and research settings. The WASI is individually administered and is designed for use with individuals aged from 6 to 89 years and it yields the three traditional Verbal, Performance, and Full Scale IQ scores. The scale is also linked to the Wechsler Adult Intelligence Scale – Third Edition and provides tables for estimating IQ score ranges on the Wechsler Adult Intelligence Scale-III (Wechsler,1997).The Wechsler Abbreviated Scale of Intelligence consists of four subtests: Vocabulary, Block Design, Similarities, and Matrix Reasoning. Administration of all four subtests is a means

of quickly estimating an individual's verbal, non-verbal, and general cognitive functioning in approximately 30 minutes (Wechsler1999).

Procedure:

Rapport was first established with the pilot and the test was administered individually according to the standard administration and scoring procedures as well as the recommended testing conditions. The test results were scored and analyzed and the descriptive statistics (mean, standard deviation, standard error of mean) were calculated. Pearson Product Moment correlation technique was used find out the relationship between the Raw Scores, T Scores and IQ Scores.

Results

Results of the WASI T Scores are shown in Table 1. Subtests T scores are in the average to above average range. Subtest scores in the high average range were attained on subtests which measure verbal concept formation, abstract verbal reasoning ability (Similarities) and nonverbal fluid reasoning (Matrix Reasoning).

Table 2 shows Verbal, Performance, and Full Scale IQ's. As it is seen in the table all the scores fell in the high average range. Performance IQ score is higher than the verbal IQ and Full Scale IQ scores in present aircrew sample. No statistically significant differences at the 0.05 level were noted on the WASI, Verbal, Performance and Full Scale IQ scores within any Demographic Variables (Rank, marital status, years of service etc.).

Table 3 shows the results of the correlation of WASI Raw scores and T scores with Sum of T scores and IQ scores. There is positive significant correlation between verbal subset Raw Scores, T Scores with Verbal Sum of T scores, Verbal IQ and Full Scale IQ scores. There is positive significant correlation between Performance subset Raw Scores, T Scores with Performance Sum of T scores, Performance IQ and Full Scale IQ scores.

Table 4 shows the result of correlations between Sum T, IQ Scores. There is a positive correlation between Verbal Sum of T scores, Verbal IQ and Full Scale IQ. There is a positive correlation between Performance Sum of T

Table 1: Intelligence T Scores in Aviators

Variable	Valid N	Mean	Minimum	Maximum	S D	SEM
Vocabulary T Scores	50	51.82	41.00	69.00	6.75	0.96
Block Design T Scores	50	56.14	46.00	65.00	4.90	0.69
Similarities T Scores	50	61.18	50.00	71.00	4.65	0.66
Matrix Reasoning T Scores	50	62.46	53.00	71.00	4.21	0.60

Table 2: Correlations between Raw scores and T scores with Sum of T scores and IQ scores

Variable	Valid N	Mean	Minimum	Maximum	S D	SEM
Vocabulary T Scores	50	51.82	41.00	69.00	6.75	0.96
Block Design T Scores	50	56.14	46.00	65.00	4.90	0.69
Similarities T Scores	50	61.18	50.00	71.00	4.65	0.66
Matrix Reasoning T Scores	50	62.46	53.00	71.00	4.21	0.60

Table 3: Correlations between Sum T and IQ Scores

Variables	Verbal Sum T Score	Verbal IQ	Performance Sum T Score	Performance IQ	Full Scale Sum T Score	Full Scale IQ
Vocabulary Raw Score	0.75**	0.75**	0.22	0.20	0.43**	0.67**
Block Design Raw Score	0.15	0.13	0.81**	0.81**	0.35**	0.57**
Similarities Raw Score	0.67**	0.65**	0.13	0.12	0.37**	0.58**
Matrix Reasoning Raw Score	0.27	0.26	0.75**	0.73**	0.37**	0.61**
Vocabulary T Score	0.87**	0.88**	0.16	0.13	0.50**	0.73**
Block Design T Score	0.09	0.07	0.84**	0.84**	0.33*	0.54**
Similarities T Score	0.70**	0.69**	0.08	0.07	0.38**	0.57**
Matrix Reasoning T Score	0.17	0.16	0.77**	0.76**	0.32*	0.56**

**p<.05 ** p<.01*

Table 4: Correlations between Sum T and IQ Scores

Variables	Verbal Sum T Score	Verbal IQ	Performance Sum T Score	Performance IQ	Full Scale Sum T Score	Full Scale IQ
Verbal Sum T Score	1.00					
Verbal IQ	0.99**	1.00				
Performance Sum T Score	0.15	0.14	1.00			
Performance IQ	0.13	0.11	0.99**	1.00		
Full Scale Sum T Score	0.55**	0.56**	0.40**	0.40**	1.00	
Full Scale IQ	0.82**	0.81**	0.68**	0.66**	0.64**	1.00

**p<.05 ** p<.01*

scores, Performance IQ and Full Scale IQ. Verbal IQ is highly correlated to Full Scale IQ compared to Performance IQ. Given the small sample sizes available, caution should be taken to limit interpretation and generalization of subgroup comparison results.

Discussion

The results of the present study on the WASI suggests that the aviators taken for the study as group demonstrated relatively average levels of functions in Vocabulary sub test (which measures, expressive vocabulary, verbal knowledge, fund of information, and crystallized intelligence). They have also demonstrated average level of functions in the Block Design subtest (which measures, spatial visualization, visual-motor coordination, and abstract conceptualization functioning). Aviators demonstrated relatively high average level of functions in both the Similarity subtest (which measures verbal concept formation, and abstract verbal reasoning ability) and in Matrix Reasoning subtest (which measures nonverbal fluid reasoning ability).

In a study using Multidimensional Aptitude Battery (MAB), 350 white male US Air Force pilots (Retzlaff & Gibertini, 1988), and another study, on astronaut aspirant candidates using MAB (Bishop, Faulk & Santy,1996), the Similarity and Spatial sub tests of the MAB shows similar results to the Similarity and Matrix Reasoning sub tests of the WASI, used in the present study. This basically measures abstract verbal reasoning/concept formation and non verbal fluid reasoning ability respectively and most of the time it is culture fair in nature. In these two studies, mean T scores of Vocabulary subset on MAB are different from the present study, basically due to the MAB being a different type of test from the WASI used in the present study. The verbal stimuli and difficulty levels of stimuli in the two tests i.e. MAB and WASI differ.

In the present study when aviators were compared amongst themselves in terms of demographic characteristics (like marital status, rank (Flg Offr, Flt Lt, etc.), flying hours, years of service and stream), no significant statistical differences were found. These results were not entirely as expected and may be an aberration due to the small sample sizes in different categories. The absence of women as pilot candidates precludes any assessment of pilots within the genders in the present study.

The military aviators, as a group, obtained scores that reflect high average abilities in Verbal IQ (110), Performance IQ (115) and Full Scale IQ (114), i.e. mean aviators subtest scores fall in the middle of the average to the high average range (110-119). Thus, the intellectual abilities of aviators in this sample surpassed the level found in the general population (general population mean is 100). In a study conducted by Retzlaff and Gibertini (1988) using MAB on US aviators, scores of performance IQ (121) and Full Scale IQ (120) are relatively similar to the present study (115 and 114). Verbal IQ is less than performance and full scale IQ in both the previous and the present study. Similar results in both the studies indicate the demonstration of a superiority of visual over verbal skills in pilots. It is not surprising, given that a higher degree of pilot skills rely on the visual domain.

The present study showed similar range of results with some previous studies conducted by various researchers which yielded a Full Scale IQ of 114 on Wechsler Adult Intelligence Scale-Revised (Guilmette, & Treanor,1986), and a Full Scale IQ score of 119 on Wechsler Adult Intelligence Scale-Revised (Fine & Hartman,1968) on an aviator population. A Full Scale IQ of above 110(Sekiguchi, Umikura, None & Kume,1994)was reported on astronaut aspirant candidates. Other studies on aviators and astronaut aspirant candidates showed different results (Retzlaff and Gibertini, 1988; Orme, Ree, & Rioux,2000; Bishop, Faulk & Santy,1996; Santy, 1994). In all these studies IQ scores of those aviator groups were higher than the aviators in the present study. This is basically due to the different Intelligence tests which were used for these studies; MAB (Retzlaff and Gibertini, 1988; Orme, Ree, & Rioux, 2000; Bishop, Faulk & Santy, 1996), Wechsler Adult Intelligence Scale (Bishop, Faulk & Santy,1996; Santy, 1994), and Wechsler Adult Intelligence Scale-Revised (Bishop, Faulk & Santy,1996; Santy, 1994) were developed long ago and the items difficulty may be less than that of WASI, which is developed more recently (1999). Secondly, in three of the above studies the IQ scores were of astronaut aspirant candidates and astronauts groups (Bishop, Faulk & Santy,1996; Santy, 1994) and not of military aviators, as in the present study. Only intellectually superior candidates remained after the screening process.

In two of the above studies which used Wechsler Adult Intelligence Scale- Revised (Guilmette, & Treanor,1986; Fine & Hartman, 1968),aviators' intellectual ability on performance sub tests yielded the Performance IQ which is similar to the Performance IQ score in the present study which used WASI. In both studies scores of Full Scale IQ and Performance IQ assessed using Wechsler Adult Intelligence Scale-Revised on aviators is similar to these IQ component results of the present study. Wechsler Adult Intelligence Scale-Revised performance sub tests and WASI performance Sub tests on an average are similar in terms of measuring spatial visualization, visual-motor coordination, abstract conceptualization functioning and non-verbal fluid reasoning ability. Some previous studies done on a different population showed dissimilar results (Bishop, Faulk & Santy, 1996; Santy, 1994; Retzlaff and Gibertini, 1988). These performance IQ scores were higher than the present study which is probably due to the different tests which are used for measuring the intellectual

ability. Also Herrnstein and Murray (1994) reported that white Americans typically score high on subtests of spatial-perceptual ability than East Asians.

In various studies performance of the aviators and astronaut candidates on verbal sub tests of the Intelligence scale is reported (Guilmette, & Treanor,1986; Fine & Hartman, 1968; Bishop, Faulk & Santy, 1996; Santy, 1994; Retzlaff & Gibertini, 1988) higher than the Verbal IQ of the present study on WASI. Herrnstein and Murray (1994) reported that East Asian scores are typically the same or slightly lower than White American scores on Verbal IQ. In the present study all the aviators are Indians and most of the previous studies consisted of aviators who were white Americans. And also in the present study English was the aviators' second language and may be because of this they scored less in Verbal IQ, because in the WASI verbal sub test items were standardized and difficulty level is set for the US English speaking population.

In the present study, there is no significant relationship between the Vocabulary subtest and the Similarity subtest (parts of verbal sub test) T scores even though both together conventionally measure the same verbal IQ component almost in the same strength. In the standardized population the Vocabulary sub test T score has a high correlation (r= 0.79) with Similarity sub test T score. This does not hold true in the case of aviators sample taken for the present study. There are three possible reasons for this observation. First is the use of English language which is not the mother tongue of any of the pilots' taken for this study. Second is the use of verbal items which are not standardized on Indian population. And finally the difficulty level of verbal stimuli in both the sub tests.

In the other subtests there is a positive correlation between the Raw Scores, T Scores, IQ scores and with in IQ scores in the present study, which is similar to the results of standardized population. It is because of all the four subtests (Vocabulary, Similarity, Matrix Reasoning, and Block Design) of WASI are the subtests with the highest loading on g, or general intellectual functioning and they were chosen for their strong association with general cognitive abilities (Brody,1992; Kamphaus,1993; Kaufman, 1990; Sattler,1988; Wechsler, 1991; Wechsler, 1997).

Limitation and Suggestions

The present study has a number of limitations due to the various practical issues involved in conducting the research. Firstly, the WASI, which is used for the present study is not standardized on Indian population. Secondly, in this study equal numbers of subjects were not taken to assess the demographic characteristic variables, resulting in low number of subjects in different categories. Thirdly the number of subjects (n= 50) taken for this study was not sufficient to construct norms on intellectual abilities of the military aviators population. Finally, the WASI used to assess the intellectual abilities of the aviators, can only assess the crystallized and fluid intelligence and not other intellectual abilities like perceptual organization and working memory.

A number of suggestions can be given for future studies in this area. A larger number of subjects can be studied in both the overall group and the sub categories of each of the demographic characteristics. The WASI test needs to be standardized on the Indian population. In the long run researchers can try to validate the intelligence test and other tests which are used in pilot selection with the WASI.

Conclusion

The objective psychological assessment of pilots is an important task. The present study reports one of the reliable and valid IQ instruments (WASI) which can be administered on individuals quickly and inexpensively. Pilots in general have highly developed

visuo-motor, visuo-spatial, and visuo-perceptual skills. Each of these functions is adequately tapped by the WASI performance subtests. Individual pilots who come to the attention of medical personnel can be given this battery of tests along with the usual assessment techniques and their result can be compared to the present sample. Significant differences from the norms may suggest diagnostic possibilities. Clinical applicability could be further enhanced with collection of more normative data on the intellectual capabilities of aviators. With that accomplished, evaluations of individual aviators intellectual abilities would become a more valid enterprise. In addition the baseline data on aviators can be used as a reference data in astronaut crews' selection and screening process.

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