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BASIC ATTRIBUTES TEST (BAT): A PRELIMINARY COMPARISON BETWEEN RESERVE OFFICER TRAINING CORPS (ROTC) AND OFFICER TRAINING SCHOOL (OTS) PILOT CANDIDATES

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The Basic Attributes Test (BAT) battery is a set of computer-administered personnel tests designed to assess a broad range of attributes believed to be related to flying training performance. The original battery consisted of 15 tests that measured psychomotor coordination, cognitive and perceptual abilities, and personality and attitudinal characteristics.

This report focuses on the development of interim score profiles for eight of the BAT tests for Reserve Officer Training Corps (ROTC) and Officer Training School (OTS) pilot candidates. Comparisons between the two groups indicate that although the OTS group consistently scored higher on the Air Force Officer Qualifying Test (AFOQT) than did the ROTC group, the two groups scored very similarly on the BAT battery.

A factor analysis was performed to provide insight into the ability domains assessed by the BAT battery. The six factors that emerged suggest that the eight tests are fairly independent.

Finally, research regarding the utility of the BAT battery for pilot selection and classification is reviewed briefly and suggestions are made regarding future development of the test battery.

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SUMMARY

The Basic Attributes Test (BAT) battery is a set of computer-administered personnel tests designed to assess a broad range of attributes believed to be related to flying training performance. The original battery consisted of 15 tests that measured psychomotor coordination, cognitive and perceptual abilities, and personality and attitudinal characteristics.

This report focuses on the development of interim score profiles for eight of the BAT tests for Reserve Officer Training Corps (ROTC) and Officer Training School (OTS) pilot candidates. Comparisons between the two groups indicate that although the OTS group consistently scored higher on the Air Force Officer Qualifying Test (AFOQT) than did the ROTC group, the two groups scored very similarly on the BAT battery. The OTS advantage on the AFOQT may have occurred because OTS candidates took the AFOQT after achieving a higher level of education than that achieved by the ROTC students at the time they took the test. In contrast, the BAT battery was administered to the ROTC and OTS students at about the same point in the selection process.

Results of a factor analysis performed to provide insight into the ability domains assessed by the BAT battery are discussed. The six factors that emerged suggest that the eight tests are fairly independent.

Finally, research regarding the utility of the BAT battery for pilot candidate selection and classification is reviewed briefly and suggestions are made regarding future development of the test battery.

PREFACE

The present investigation was conducted under work unit 77191845 in support of Request for Personnel Research (RPR) 78-11, Selection for Undergraduate Pilot Training, issued by the Air Training Command.

Appreciation is extended to Mr. Ed Watkins and his staff from OAO, Inc. for their efforts in preparing the data files and programming the data analyses, and to Ms. Nancy Garay and Ms. Sandra Garcia for administrative support. Finally, the author extends thanks to Major Dave Perry, Dr. Joseph L. Weeks, and Dr. William E. Alley for their guidance and technical support during this project.

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I. INTRODUCTION

The Basic Attributes Test (BAT) battery is a set of computer-administered personnel tests developed for individual administration under standardized conditions (Carretta, 1987a). The BAT battery is designed to provide measures of psychomotor skills, cognitive and perceptual abilities, personality characteristics, and attitudes believed to be related to United States Air Force (USAF) flying training performance (Imhoff & Levine, 1981).

Since 1983, when administration of the BAT to USAF pilot candidates began, the original 15 tests have been evaluated in terms of their utility for predicting flying training performance (Carretta, 1988b; Siem, 1988). Results from these studies suggest that performance information from a subset of the original 15 tests provides the greatest gains in predictive validity when combined with the Air Force Officer Qualifying Test (AFOQT), the personnel test currently used to provide individual abilities information for aircrew selection and classification.

Purpose

The purpose of the present investigation was to develop an interim scoring profile for BAT score interpretation based on pilot candidates commissioned through the Reserve Officer Training Corps (ROTC) and the Officer Training School (OTS) programs. Only those eight BAT tests which have demonstrated the greatest potential for adding to the predictive validity of the AFOQT are treated in detail here. Table 1 provides a brief description of these tests. A more detailed description is provided later. For completeness, descriptions of the remaining seven tests are provided in Appendix B.

II. METHOD

Subjects

The subjects in this study were USAF officer candidates from the ROTC (N = 350) and OTS (N = 705) commissioning programs who were tested on the AFOQT and the BAT. These subjects had already been chosen for Undergraduate Pilot Training (UPT), in part on the basis of their AFOQT scores. Subjects were informed that the study involved performing experimental computerized tests being considered for operational use. They also were told their performance would not affect their status in the program, would be kept confidential, and would be used only for research purposes. Not all subjects had scores on all eight BAT tests considered here because of changes in the test composition of the BAT battery over the administration period. Demographic information regarding the ROTC and OTS samples is provided in Table 2.

Tests

Air Force Officer Qualifying Test

AFOQT Form 0 is a paper-and-pencil test battery that consists of 16 subtests which produce five composite percentile scores: verbal, quantitative, academic aptitude (verbal and quantitative combined), pilot, and navigator-technical. Of these five composites, only two--the pilot and navigator-technical composites--are used in the operational selection of pilot candidates (U.S. Air

Table 1. **Basic Attributes Test (BAT) Battery Summary**

Test name	Length (min)	Attributes measured	Measures of interest	Reference
1. Test Battery Introduction	15	Biographical Information	Age, handedness, previous flying experience, etc.	(none)
2. Two-Hand Coordination (rotary pursuit)	10	Tracking & time-sharing ability in pursuit	Tracking error	Fleishman, 1964
3. Complex Coordination (stick and rudder)	10	Compensatory tracking involving multiple axes	Tracking error	Fleishman, 1964; McGrevy & Valentine, 1974
4. Encoding Speed	20	Verbal classification	Response time, response accuracy	Posner & Mitchell, 1967
5. Mental Rotation	25	Spatial transformation and classification	Response time, response accuracy	Shepard & Metzler, 1971
6. Item Recognition	20	Short-term memory (storage search and comparison)	Response time, response accuracy	Sternberg, 1966
7. Time-Sharing	30	Higher-order tracking ability, learning rate and time-sharing ability	Tracking difficulty, learning rate, response time on secondary task, tracking/response time trade-off	North & Gopher, 1976
8. Self-Crediting Word Knowledge	10	Self-assessment ability, self-confidence	Response time, response accuracy, subject's prediction of own performance	Mullins, 1962
9. Activities Interest Inventory	10	Survival attitudes	Response time, number of high-risk choices	Mullins, 1962

Note. These tests have demonstrated the potential to add to the predictive validity of the AFOQT when predicting USAF flying training performance. Detailed descriptions of these eight tests are provided in the text. The remaining BAT tests are described in Appendix B.

Force, 1983). AFOQT subtest scores are usually represented as raw test scores, whereas the composite indices are percentile scores that may range from 01 to 99 percent.

Table 2. **Demographic Data for ROTC and OTS Samples**

Variable		ROTC (N = 350)	OTS (N = 705)
Sex (%):	Male	99.4 [99.4]	98.9 [98.9]
	Female	0.6 [0.6]	1.1 [1.1]
Race (%):	Black	0.0 [0.0]	1.3 [1.5]
	White	11.4 [100.0]	85.5 [98.5]
	Missing data	88.6	13.2
Age (mean no. of yrs):		20.5	24.0

Note. Many subjects did not have valid data for race. The percentages in brackets indicate the percentage of the sample when only cases with valid data are considered.

In Appendix A, Table A-1 provides a brief description of the 16 subtests included in AFOQT Form 0; Table A-2 shows the subtest composition of each of the five AFOQT composites. Table 3 summarizes AFOQT composite and subtest score comparisons between the ROTC and OTS samples.

Table 3. **Summary of AFOQT Comparisons Between ROTC and OTS Samples**

	ROTC (N = 350)		OTS (N = 705)		Two-tailed
Variable	**Mean**	**SD**	**Mean**	**SD**	**t-test**
AFOQT Composite Percentile Scores:					
Verbal	60.5	22.1	68.9	20.3	-6.14**
Quantitative	66.3	19.2	67.5	20.2	-0.88
Academic Aptitude	64.3	20.6	70.0	18.7	-4.53**
Pilot	72.1	15.0	78.0	14.7	-6.09**
Navigator-Technical	71.8	16.5	75.00	16.1	-2.99**
AFOQT Subtest Scores:					
Verbal Analogies	15.8	2.8	16.3	2.8	-2.90**
Arithmetic Reasoning	13.7	3.4	14.3	3.5	-2.66**
Reading Comprehension	18.6	4.3	19.9	3.6	-5.19**
Data Interpretation	13.8	3.0	14.7	3.1	-4.56**
Word Knowledge	14.6	4.8	16.8	4.6	-7.07**
Math Knowledge	19.0	4.1	18.3	4.6	2.44*
Mechanical Comprehension	11.9	2.9	13.0	2.9	-5.97**
Electrical Maze	10.4	4.2	10.6	4.3	-0.47
Scale Reading	24.9	4.8	26.1	4.8	-3.96**
Instrument Comprehension	14.1	3.8	14.6	3.9	-2.00*
Block Counting	13.7	3.3	13.9	3.4	-0.97
Table Reading	31.1	5.1	32.0	5.5	-2.43*
Aviation Information	11.0	3.6	13.4	3.9	-9.63**
Rotated Blocks	10.2	2.4	9.9	2.6	1.81
General Science	10.2	3.4	11.0	3.4	-3.31**
Hidden Figures	11.3	2.3	11.2	2.3	0.33

*$p \leq .05$.
**$p \leq .01$.

Basic Attributes Test

Each of the tests in the BAT battery was adapted from tests in the research literature that were identified as potentially useful predictors of flying performance (Imhoff & Levine, 1981). The criteria used to select the tests included feasibility, interest of the test-taker, independence from other tests in the battery, construct validity, and minimal dependence on verbal materials for administration. The BAT battery was designed to measure a variety of psychomotor skills, information processing abilities, and personality characteristics that are considered important in determining the suitability of a candidate for flight training. A summary of the most promising pilot candidate selection and classification tests from the BAT battery is provided in Table I. It indicates the name, length, attribute measured, measures of interest and origin for each test. Individual test summaries are presented below. Illustrations of BAT test items are provided in Appendix C, and detailed scoring procedures are provided in Appendix D. BAT apparatus specifications and details regarding hardware and software development are provided in Carretta (1987a).

Test Battery Introduction. This interactive subprogram prompts the subject to provide background information (e.g., identity, age, gender), as well as personal history and attitudes related to flying.

Two-Hand Coordination. Two tests are used to evaluate psychomotor abilities. The first, the Two-Hand Coordination Test, is a rotary pursuit task. An airplane (target) moves in an elliptical path on the screen at a rate of 20 cycles per minute. The rate of movement of the airplane within each cycle varies in a fixed sinusoidal pattern. The subject controls the movement of a small "gunsight" using a left-hand joystick for vertical movement of the gunsight and a right-hand joystick for horizontal movement of the gunsight. The subject's task is to keep the gunsight on the moving airplane. After receiving instructions, the subject completes a 3-minute practice session and a 5-minute test. The measures of interest are horizontal and vertical tracking error scores. The psychological factors assessed in the Two-Hand Coordination Test are low-to-moderate-order tracking and time-sharing ability in pursuit.

Complex Coordination. The Complex Coordination Test uses a dual-axis joystick (right-hand joystick) to control the horizontal and vertical movement of a cursor. The left-hand single-axis joystick controls the horizontal movement of a "rudder bar" at the base of the screen. The subject's task is to keep the cursor (against a constant horizontal and vertical rate bias) centered on a large cross fixed at the center of the screen, while simultaneously centering the rudder bar at the base of the screen (also against a constant rate bias). The instructions, practice, testing, and scoring are the same as those in the Two-Hand Coordination Test. The Complex Coordination Test assesses compensatory tracking ability involving multiple-axis continuous events.

Encoding Speed. Two letters are presented simultaneously to the subject, who is required to make a same-different judgment about the letter pair. The judgment may be based on a Physical Identity rule (look the same or look different, AA versus Aa), a Name Identity rule (same name or different name, AA versus AH) or Category Identity rule (vowels versus consonants - AE versus AH). The reaction time for the judgment provides a measure of the speed of the cognitive encoding process.

Reaction time and accuracy of response (correct/incorrect) are recorded on each of the 96 trials (32 trials in each rule condition). The psychological factor involved in this test is verbal classification at several levels of cognitive operation.

Mental Rotation. A pair of letters are presented sequentially, and the subject is required to make a same-different judgment. Elements of the letter pair may be either identical or mirror images, and the letters may be either in the same orientation or rotated in space with respect

to each other. A correct "different" judgment occurs when one element of a pair is a mirror image of the other, regardless of orientation.

To take the test, the subject must form a mental image of the first letter (no longer displayed) and perform a point-by-point comparison with the second letter (which remains on the screen). In addition, when the letters are rotated with respect to each other, the subject must mentally rotate the mental image of one letter into congruence with the other prior to making the comparison.

Reaction time and accuracy of response are recorded on each of the 72 trials. The psychological factors assessed by this test are spatial transformation and classification.

Item Recognition. In this test, a string of one to six digits is presented on the screen. The string is then removed and followed, after a brief delay, by a single digit. The subject is instructed to remember the initial string of digits, then to decide if the single digit was one of those presented in the initial string. The subject is instructed to press a keypad button marked YES if the single digit was in the string, or press another marked NO if the digit was not in the string. The instructions inform the subject to work as quickly and accurately as possible. Reaction time and accuracy of response are recorded on each of the 48 trials. Short-term memory storage, search, and comparison operations are the underlying psychological factors for this test.

Time-Sharing. During a series of 10 1-minute trials, the subject is required to learn a compensatory tracking task. To perform this task, the subject must anticipate the movement of a gunsight on a screen and operate a control stick to counteract that movement in order to keep the gunsight aligned with a fixed central point (an airplane). Task difficulty is adjusted throughout the test, depending on the subject's performance. The gunsight movement control dynamics are a combination of rate and acceleration components. The "disturbance" factor is a quasi-random summed sinusoidal forcing function.

After these "tracking only" trials, the subject is required to track while cancelling digits that appear at random intervals and locations on the screen. A digit is cancelled when the subject presses the corresponding button on the keypad. If the subject fails to respond to a digit within 4 seconds after its appearance time, the gunsight will disappear until a digit response is made. These dual-task trials occur in two 3-minute blocks. The information processing load gradually increases during these trials. The Time-Sharing Test ends with a final 3-minute block of "tracking only" trials. There are a total of 19 1-minute trials (10 tracking only, 6 dual-task, and 3 more tracking only).

The effects of the secondary task loads are reflected in the pattern of level of tracking difficulty changes caused by the adaptive logic that holds tracking error constant. Feedback concerning tracking difficulty is provided by a gauge that appears in the top right of the screen. The measures of interest for this test include the level of tracking difficulty at which the subject can perform consistently, response time on the secondary task, and dual-task performance.

This test assesses a variety of psychological factors including higher-order tracking ability, and learning rate and time-sharing ability as a function of differential task load.

Self-Crediting Word Knowledge. This test is essentially a vocabulary test wherein a "target" word is presented to the subject along with five other words from which its closest synonym must be chosen. There are three blocks of 10 questions each. The target words become increasingly difficult with each successive block. Subjects are informed of this increasing difficulty and are required to make a "bet" prior to each block as to how well they expect to do. Response time and accuracy are recorded on each of the 30 trials. This test assesses self-assessment ability and self-confidence.

Activities Interest Inventory. This test is designed to determine the subject's interest in various activities. In this test, 81 pairs of activities are presented, and the subject is asked to choose between them. The subject is told to assume that he/she has the necessary ability to perform each activity. The activity pairs force the subject to choose between tasks that differ as to degree of threat to physical survival (sometimes subtly, sometimes not). The measures of interest are the number of high-risk options chosen and the amount of time required to choose between pairs of activities. The psychological factor assessed by this test is attitude toward risk-taking.

Apparatus

The Basic Attributes Test (BAT) apparatus, shown in Appendix C (Figure C-9), consisted of a microcomputer built into a ruggedized chassis with a glare shield and side panels designed to eliminate distractions. Each subject responded to the test stimuli by using individually, and in combination, a two-axis joystick on the right side of the apparatus, a single-axis joystick on the left side, and a keypad in the center of the test unit. The keypad included the number keys 0 to 9, an ENABLE key in the center, and a bottom row with YES and NO keys and two others labeled S/L (for same/left responses) and D/R (for different/right responses).

Procedure

Each subject completed both the AFOQT and the BAT. Pilot candidates were commissioned through either ROTC or OTS. Candidates commissioned through ROTC took the AFOQT between their senior year in high school and their junior year in college. They completed the BAT during the summer following their junior year in college. For OTS pilot candidates, the AFOQT was administered either during their final year in college or after the completion of college and the BAT was administered at the beginning of their participation in a Flight Screening Program (FSP).

After the test administrator initiated the BAT system, the test session was self-paced for each subject. The test session lasted about 3 1/2 hours and included programmed breaks between tests to avoid mental and physical fatigue.

Analysis

Test performance on the AFOQT by the ROTC and OTS samples was evaluated using descriptive and inferential statistical procedures. The objective was to determine whether there were significant AFOQT performance differences between the ROTC and OTS pilot candidates that might affect their performance on the BAT battery.

Performance on the eight BAT tests was examined in a similar manner for the ROTC and OTS samples. A factor analysis was performed to evaluate relationships among the BAT summary scores.

III. RESULTS AND DISCUSSION

Air Force Officer Qualifying Test

As shown in Table 3, OTS pilot candidates consistently scored higher than their ROTC counterparts on the AFOQT composites. The OTS group scored significantly higher on four of the five composites and 11 of the 16 subtests, whereas the ROTC group scored significantly higher on only the Math Knowledge subtest. As previously noted, ROTC cadets take the AFOQT between their senior year in high school and completion of their junior year in college. OTS candidates usually take the AFOQT upon completing the baccalaureate degree. The OTS advantage may be due to taking the AFOQT after having achieved a higher educational level. Steuck, (in press) reported similar score differences for an unscreened group of ROTC and OTS officer candidates.

These score differences do not influence the comparative likelihood of selection for pilot training for members of the two groups, as ROTC and OTS pilot training candidates are evaluated by separate selection boards.

Basic Attributes Test

Descriptive Measures

For all of the tests in the BAT battery, tracking error scores, response latencies, and response choice/accuracy are used to assess individual differences in performance. These types of scores tend to exhibit extremely skewed, non-normal distributions. It is difficult to interpret summary statistics from such distributions as both means and standard deviations tend to be distorted by extreme scores. To reduce this effect, all BAT scores that were more than three standard deviations from the mean were recoded to be exactly three standard deviations from the mean. In most instances this affected only a few scores; however, up to 8.85% of the scores for a test were affected. Even after recoding, some distributions were skewed. See Tables 4 and 5 for detailed descriptions of the ROTC and OTS BAT score distributions. Estimates of the internal consistency of the test items are provided in Appendix D (Table D-1).

ROTC Versus OTS Comparisons

Although the ROTC and OTS groups exhibited differences in performance on the BAT battery, the direction of the differences did not clearly favor one group over the other. Table 6 summarizes comparisons between the ROTC and OTS group mean scores.

The two groups did not differ in a consistent manner in tracking performance. The OTS group had marginally lower X2 tracking error scores on the Complex Coordination Test ($\underline{M}$ ROTC = 9,497.5, $\underline{M}$ OTS = 8,421.0; $\underline{t}$ [1053] = 2.29, $\underline{p} \leq .05$). However, the ROTC group performed at a higher average tracking difficulty on the compensatory tracking task used in the Time-Sharing Test ($\underline{M}$ ROTC = 263.7, $\underline{M}$ OTS = 256.2; $\underline{t}$ [1053] = 3.19, $\underline{p} \leq .01$).

Results from the other six tests also were mixed. ROTC subjects made quicker responses on two of the cognitive and perceptual abilities tests including Mental Rotation average response time ($\underline{M}$ ROTC = 407.0 milliseconds (ms), $\underline{M}$ OTS = 449.0 ms; $\underline{t}$ (1053) = -2.56, $\underline{p} \leq .05$) and Time-Sharing average response time ($\underline{M}$ ROTC = 1,202.8 ms, $\underline{M}$ OTS = 1,238.5 ms; $\underline{t}$ [1053] = -2.66, $\underline{p} \leq .01$). OTS subjects achieved a higher level of accuracy than did the ROTC subjects on three of the cognitive abilities tests (Encoding Speed, Mental Rotation and Item Recognition), although this difference was statistically significant for only the Item Recognition Test ($\underline{M}$ ROTC = 94.3% correct, $\underline{M}$ OTS = 95.1% correct; $\underline{t}$ [957] = -2.81, $\underline{p} \leq .01$).

On the two personality-type BAT tests, ROTC subjects required more time to make decisions and were less willing to take risks than were the OTS subjects. For instance, on the Self-Crediting Word Knowledge Test, a test of self-confidence, ROTC subjects took longer to make decisions (average response time: $\underline{M}$ ROTC = 7,812.2 ms, $\underline{M}$ OTS = 7,592.5 ms; $\underline{t}$ [1053] = 2.30, $\underline{p} \leq .05$) and had lower expectations about their performance (bet less; $\underline{M}$ ROTC = 38.0, $\underline{M}$ OTS = 40.2; $\underline{t}$ [1053] = -4.26, $\underline{p} \leq .01$) than did their OTS counterparts. In addition, the ROTC subjects were less accurate on this test ($\underline{M}$ ROTC = 63.7% correct, $\underline{M}$ OTS = 67.2% correct; $\underline{t}$ [1053] = -5.30, $\underline{p} \leq .01$). One explanation for the group differences in performance on this test may reside in the nature of the test items. The Self-Crediting Word Knowledge Test is essentially a vocabulary test in which the subject makes predictions about his/her performance. In that the ROTC subjects had lower scores on the AFOQT vocabulary subtest (Word Knowledge), their poorer performance and lower expectations on the Self-Crediting Word Knowledge Test are not surprising. If self-confidence levels had been assessed using another ability domain, the results might have been different.

Table 4. **Descriptive Statistics for ROTC BAT Battery Scores**

Test score	Mean	SD	Minimum	Maximum	Skew	Kurtosis	% of extreme scores recoded
Two-Hand Coordination:							
X1 Tracking Error	11,646.4	4,526.4	5,265.0	35,000.0	1.65	4.40	0.57
Complex Coordination:							
X2 Tracking Error	9,497.5	7,258.2	832.0	26,525.0	1.11	0.02	8.85
Y2 Tracking Error	8,781.3	9,258.2	399.0	35,000.0	1.81	2.34	8.20
Z2 Tracking Error	7,129.1	6,154.6	657.0	35,000.0	2.33	6.15	0.98
Encoding Speed:							
Avg RT (ms) - correct responses	738.0	149.4	446.1	1,150.0	0.80	0.18	1.97
Percent Correct (%)	90.9	4.7	70.8	100.0	-0.38	0.36	0.00
Avg RT x % Correct	3,733.3	8,242.6	-18,000.0	24,000.0	0.38	0.74	5.90
Mental Rotation:							
Avg RT (ms) - correct responses	407.0	211.3	111.4	1,250.0	1.64	3.10	0.98
SD RT (ms) - correct responses	988.5	283.2	355.4	1,800.0	0.96	0.68	1.97
Percent Correct (%)	90.2	8.4	65.0	100.0	-1.57	2.18	5.57
Item Recognition:							
Avg RT (MS) - correct responses	861.6	201.2	554.6	1,450.0	0.88	0.39	1.91
Slope (RT)	-18.5	20.6	-80.0	40.0	-0.16	1.02	1.91
Intercept (RT)	927.6	229.4	564.4	1,700.0	0.89	0.63	0.38
Percent Correct (%)	94.3	4.4	80.0	100.0	-1.15	1.30	1.15
Time-Sharing:							
Slope (Tracking Difficulty)	6.4	11.1	-25.0	35.0	0.20	0.68	4.59
Intercept (Tracking Difficulty)	294.3	101.3	0.0	623.7	-0.53	1.06	1.71
Avg Tracking Difficulty	263.7	36.5	150.0	335.6	-0.68	0.60	1.43
Avg RT (ms)	1,202.8	188.2	863.6	1,800.0	1.16	1.61	2.29
Avg RT x Tracking Difficulty	300,878.5	55,924.8	150,000.0	450,000.0	0.34	0.67	3.43

Table 4. (Concluded)

Test score	Mean	SD	Minimum	Maximum	Skew	Kurtosis	% of extreme scores recoded
Self-Crediting Word Knowledge:							
Avg RT (ms) - correct responses	7,812.2	1,596.6	3,942.0	11,500.0	0.20	-0.33	1.97
Percent Correct (%)	63.7	10.1	30.0	96.7	0.02	0.39	0.00
Avg RT x % Correct	-2,129.6	16,333.5	-45,000.0	45,000.0	-0.28	1.70	5.90
Bet	38.0	8.1	13.3	50.0	-0.31	-0.37	0.00
Activities Interest Inventory:							
N High-Risk Choices	50.0	9.2	25.0	74.0	-0.07	-0.39	0.00
Avg RT (ms)	4,275.5	905.2	2,409.0	7,000.0	0.03	-0.04	1.31

Note. The number of ROTC subjects tested was 350 for all tests except Item Recognition, which had only 261 subjects.

Table 5. **Descriptive Statistics for OTS BAT Battery Scores**

Test score	Mean	SD	Minimum	Maximum	Skew	Kurtosis	% of extreme scores recoded
Two-Hand Coordination:							
X1 Tracking Error	11,531.8	5,293.7	2,461.0	35,000.0	1.10	1.93	0.28
Complex Coordination:							
X2 Tracking Error	8,421.0	6,967.4	228.0	26,525.0	1.29	0.71	5.25
Y2 Tracking Error	7,776.7	8,559.4	636.0	35,000.0	2.13	3.84	5.82
Z2 Tracking Error	7,303.8	7,000.3	660.0	35,000.0	2.34	5.68	2.41
Encoding Speed:							
Avg RT (ms) - correct responses	743.9	137.0	480.9	1,150.0	0.94	0.70	1.84
Percent Correct (%)	91.0	4.4	75.0	100.0	-0.33	-0.30	0.00
Avg RT x % Correct	3,104.1	7,462.9	-18,000.0	24,000.0	0.63	1.55	3.83
Mental Rotation:							
Avg RT (ms) - correct responses	449.0	268.0	115.8	1,250.0	1.38	1.33	2.84
SD RT (ms) - correct responses	924.5	333.5	88.3	1,800.0	0.24	0.48	2.27
Percent Correct (%)	90.7	8.4	65.0	100.0	-1.62	2.19	3.69
Item Recognition:							
Avg RT (ms) - correct responses	868.1	216.2	454.9	1,450.0	0.88	0.42	2.58
Slope (RT)	-18.3	23.6	-80.0	40.0	-0.13	0.61	3.44
Intercept (RT)	934.2	252.0	460.5	1,700.0	1.06	1.04	2.01
Percent Correct (%)	95.1	4.0	80.0	100.0	-1.11	1.25	0.43
Time-Sharing:							
Slope (Tracking Difficulty)	6.5	9.9	-20.8	35.0	0.27	0.35	1.13
Intercept (Tracking Difficulty)	283.6	94.9	0.0	517.1	0.52	0.48	0.71
Avg Tracking Difficulty	256.2	35.9	150.0	337.8	-0.49	0.02	0.85
Avg RT (ms)	1,238.5	213.3	779.5	1,800.0	0.80	0.27	2.84
Avg RT x Tracking Difficulty	300,482.4	59,546.2	150,000.0	450,000.0	0.45	0.12	3.26

Table 5. (Concluded)

Test score	Mean	SD	Minimum	Maximum	Skew	Kurtosis	% of extreme scores recoded
Self-Crediting Word Knowledge:							
Avg RT (ms) - correct responses	7,592.5	1,386.0	3,586.5	11,500.0	0.18	-0.09	0.57
Percent Correct (%)	67.2	10.0	36.7	96.7	0.18	0.15	0.00
Avg RT x % Correct	-3,365.1	14,231.9	-45,000.0	45,000.0	-0.62	1.86	2.41
Bet	40.2	7.9	10.0	50.0	-0.64	0.04	0.00
Activities Interest Inventory:							
N High-Risk Choices	51.7	9.7	23.0	76.0	0.11	-0.38	0.00
Avg RT (ms)	4,566.4	964.7	2,197.0	7,000.0	0.26	-0.30	1.70

Note. The number of OTS subjects was 705 for all tests except Item Recognition, which had only 697 subjects.

Table 6. **Summary of BAT Comparisons between ROTC and OTS Samples**

Test score	ROTC (N = 350) Mean	SD	OTS (N = 705) Mean	SD	Two-tailed t-test
Two-Hand Coordination:					
X1 Tracking Error	11,646.4	4,526.4	11,531.8	5,293.7	0.35
Complex Coordination:					
X2 Tracking Error	9,497.5	7,599.6	8,421.0	6,967.4	2.29*
Y2 Tracking Error	8,781.3	9,258.2	7,776.7	8,559.4	1.75
Z2 Tracking Error	7,129.1	6,154.6	7,303.8	7,000.3	-0.40
Encoding Speed:					
Avg RT (ms) - correct responses	738.0	149.4	743.9	137.0	-0.63
Percent Correct (%)	90.9	4.7	91.0	4.4	-0.37
Avg RT x % Correct	3,733.3	8,242.6	3,104.1	7,462.9	1.24
Mental Rotation:					
Avg RT (ms) - correct responses	407.0	211.3	449.0	268.0	-2.56*
Standard Deviation RT (ms) - correct responses	988.5	283.2	924.5	333.5	3.08**
Percent Correct (%)	90.2	8.4	90.7	8.4	-1.00
Item Recognition:					
Avg RT (ms) - correct responses	861.6	201.2	868.1	216.2	-0.42
Slope (RT)	-18.5	20.6	-18.3	23.6	-0.11
Intercept (RT)	927.6	229.4	934.2	252.0	-0.37
Percent Correct (%)	94.3	4.4	95.1	4.0	-2.81**
Time-Sharing:					
Slope (Tracking Difficulty)	6.4	11.1	6.5	9.9	-0.13
Intercept (Tracking Difficulty)	294.3	101.3	283.6	94.9	1.69
Avg Tracking Difficulty	263.7	36.5	256.2	35.9	3.19**
Avg RT (ms)	1,202.8	188.2	1,238.5	213.3	-2.66**
Avg RT x Tracking Difficulty	300,878.5	55,924.8	300,482.4	59,546.2	0.10
Self-Crediting Word Knowledge:					
Avg RT (ms) - correct responses	7,812.2	1,596.6	7,592.5	1,386.0	2.30*
Percent Correct (%)	63.7	10.1	67.2	10.0	-5.30**
Avg RT x % Correct	-2,129.6	16,333.5	-3,365.1	14,231.9	1.26
Bet	38.0	8.1	40.2	7.9	-4.26**
Activities Interest Inventory:					
N High-Risk Choices	50.0	9.2	51.7	9.7	-2.66**
Avg RT (ms)	4,275.5	905.2	4,566.4	964.7	-4.71**

Note. The number of subjects for the Item Recognition test is 261 for the ROTC group and 697 for the OTS group.

*$p \leq .05$.

**$p \leq .01$.

Results from the test concerned with assessing attitudes toward risk-taking (Activities Interest Inventory) suggest that the ROTC subjects were quicker to make decisions ($\underline{M}$ ROTC = 4,275.5 ms, $\underline{M}$ OTS = 4,566.4 ms; t [1053] = -4.71, $p \leq .01$), but less willing to take risks (number of high-risk choices: $\underline{M}$ ROTC = 50.0, $\underline{M}$ OTS = 51.7; t [1053] = -2.66, $p \leq .01$).

In most instances where there was a statistically significant difference in BAT performance between the two groups, the size of the difference was relatively small (differences of a few milliseconds in response time or less than 1 percent in response accuracy). Many of the BAT score comparisons would have been judged non-significant had the experiment-wise error rate been limited to the .05 level.

If BAT scores are incorporated into the pilot candidate selection process, differences in BAT performance between the ROTC and OTS groups would not affect the likelihood of selection for pilot training for a particular individual, because--as mentioned earlier--ROTC and OTS pilot training candidates are evaluated by separate selection boards.

Factor Structure

A factor analysis using the 25 scores from the BAT battery was performed to evaluate relationships among the eight tests. As not all subjects had scores on the Item Recognition Test, only 958 subjects were included in the factor analysis.

The BAT score correlation matrix shown in Table 7 indicates, for the most part, that performance measures from the eight tests were not related strongly to each other. The strongest "between-test" relationships occurred between measures of the same type (tracking error and tracking difficulty, response times from the cognitive tests, and response accuracy scores from the cognitive tests). Within-test correlations suggested that in some instances two or more scores from the same test were redundant (e.g., Item Recognition, average response time and intercept, r = .94; Time-Sharing, slope and intercept, r = -.72).

A principal factors analysis was conducted using the 25 BAT scores. Estimated communalities of several measures approached or exceeded 1.0, which suggested a high degree of linear dependence between some of the measures. In the instances where two or more derived scores were based on the same elements (e.g., Item Recognition - average response time, slope and intercept), all but one of the interrelated scores were eliminated. Because of this redundancy, eight of the 25 BAT scores were excluded from the factor analysis. The eliminated scores included: Encoding Speed - response time by percent correct interaction; Mental Rotation - response time standard deviation; Item Recognition - slope and intercept; Time-Sharing - slope and intercept; and response time by tracking interaction; and Self-Crediting Word Knowledge - response time by percent correct interaction. The resulting principal factors analysis yielded six factors with eigenvalues greater than 1.0. These six principal factors accounted for 61.8% of the total score variance among the 17 test scores included in the analysis. These factors were rotated both orthogonally by the Varimax method and obliquely by the Kaiser-Harris method. The two methods produced very similar results, which differed only in the order of the factors. Correlations between factors in the oblique solution ranged from r = -.36 to r = .19, suggesting that an orthogonal solution would be appropriate.

Table 8 shows the communalities and factor loadings for the final orthogonal rotation. Factor I was defined clearly by the Complex Coordination tracking error scores. Factor II appeared to represent finger dexterity, as both tracking performance and response latencies loaded heavily on it. Measures for Factors III and V represent two different components of information processing speed. Factor III can be interpreted as a perceptual speed factor in that it is defined by the response latencies from the three cognitive/perceptual abilities tests (Encoding Speed, Mental Rotation, and Item Recognition). Factor V reflects verbal information processing, in that the

Table 7. Basic Attributes Test: Test Score Correlation Matrix

Test score	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
1. PS2X1	1.00																								
2. PS2X2	.25	1.00																							
3. PS2Y2	.29	.56	1.00																						
4. PS272	.30	.68	.52	1.00																					
5. ENCRT	.17	.17	.11	.16	1.00																				
6. ENCPER	.00	.06	.03	.00	.25	1.00																			
7. ENCINT	-.04	-.10	-.05	-.10	-.60	-.42	1.00																		
8. MRTRT	-.12	.11	.06	.06	.37	.13	-.25	1.00																	
9. MRTSD	.35	.14	.16	.13	.44	.02	-.22	.32	1.00																
10. MRTPER	-.08	-.13	-.12	-.09	.01	.16	-.07	-.14	-.16	1.00															
11. ITMRT	.27	.18	.15	.16	.60	.11	-.33	.26	.51	.00	1.00														
12. ITMSLP	-.07	-.06	-.09	-.06	-.07	.00	.03	-.06	-.08	-.02	-.15	1.00													
13. ITMICP	.26	.17	.16	.16	.58	.10	-.31	.26	.49	.00	.94	-.45	1.00												
14. ITMPER	-.04	-.04	-.01	-.04	.16	.31	-.19	.06	.11	.19	.06	.05	.04	1.00											
15. TMSSLP	-.01	-.05	-.05	-.06	.00	.00	.00	-.04	-.01	-.03	-.04	-.06	-.01	.03	1.00										
16. TMSICP	-.21	-.10	-.13	-.14	-.14	.04	.03	-.07	-.15	.07	-.17	.05	-.17	-.03	-.72	1.00									
17. TMSDIF	-.33	-.20	-.23	-.27	-.22	.01	.09	-.10	-.21	.06	-.28	.03	-.27	.00	.14	.44	1.00								
18. TMSRT	.23	.10	.09	.11	.29	.02	-.15	-.03	.25	-.02	.21	-.01	.21	.05	-.02	-.11	-.26	1.00							
19. TMSRTD	-.07	-.07	-.09	-.12	.10	.00	-.09	-.08	.06	.02	-.02	.01	-.02	.05	.09	.24	.53	.64	1.00						
20. WKART	.05	-.02	-.01	.00	.15	.05	-.07	-.02	.13	-.01	.04	-.06	.06	.07	.04	-.04	.00	.21	.17	1.00					
21. WKAPER	-.05	-.02	-.10	-.02	-.05	.10	-.01	-.01	-.05	.17	.00	-.02	.01	.06	-.01	.02	.02	-.07	-.06	-.27	1.00				
22. WKAINT	-.01	.04	.07	.05	.03	-.01	-.02	.04	.01	-.07	-.07	.03	-.07	-.02	.00	.03	.03	-.02	.00	-.08	-.37	1.00			
23. WKABET	.00	-.03	-.08	-.02	-.03	.02	.02	-.01	.00	.06	-.01	.00	-.01	.01	.05	-.05	-.05	-.02	.06	.25	.48	-.15	1.00		
24. AIAHIR	-.09	-.04	-.11	-.06	-.07	.03	.03	-.02	-.12	.06	-.09	-.03	-.07	-.01	.00	.08	.11	-.08	.02	.00	.10	-.03	.11	1.00	
25. AIART	-.04	-.05	-.07	-.01	.11	-.04	-.05	-.02	.05	.06	.06	-.04	.07	.06	-.02	.06	.04	.18	.18	.41	-.16	.01	-.16	-.13	1.00

Note. The sample size for the test score correlations was only 958, as subjects without Item Recognition Test scores were not included. Test Scores 1 through 25 are presented in the same order as BAT scores on Tables 4-6. Appendix D includes the test score acronyms and their meanings.

Table 8. **Basic Attributes Test: Summary of Varimax Rotated Factor Solution**

Test score	Commun-ality	Factor loadings I	II	III	IV	V	VI
Two-Hand Coordination:							
X1 Tracking Error	.456	.253	.611	-.109	-.039	-.067	-.033
Complex Coordination:							
X2 Tracking Error	.731	.839	.107	.122	-.002	-.012	-.019
Y2 Tracking Error	.476	.638	.212	.027	-.124	-.085	-.015
Z2 Tracking Error	.644	.771	.208	.047	.018	.026	-.060
Encoding Speed:							
Avg RT	.725	.060	.425	.673	-.036	.143	.257
Percent Correct	.363	.050	-.017	.154	.016	-.045	.578
Mental Rotation:							
Avg RT	.417	.079	-.075	.634	-.027	-.048	-.003
Percent Correct	.196	-.120	-.030	-.134	.158	.076	.364
Item Recognition:							
Avg RT	.490	.071	.482	.490	.017	.042	.104
Percent Correct	.255	-.024	.002	.063	.005	.054	.497
Time-Sharing							
Avg Tracking Difficulty	.291	-.194	-.483	-.113	-.033	.043	.063
Avg RT	.266	.039	.436	.053	-.024	.264	.038
Self-Crediting Word Knowledge:							
Avg RT	.373	-.028	.087	-.004	-.292	.521	.093
Percent Correct	.589	-.019	-.061	-.021	.740	-.119	.151
Bet	.400	-.032	.036	-.001	.614	-.141	-.001
Activities Interest Inventory:							
N High-Risk Choices	.046	-.056	-.142	-.031	.120	-.071	.045
Avg RT	.529	-.051	.021	-.007	-.101	-.718	.017

Factor	Eigenvalue	% of explained variance	Cumulative % explained variance
I	2.61	35.9	35.9
II	1.48	20.4	56.3
III	1.32	18.2	74.5
IV	0.71	9.8	84.3
V	0.69	9.5	93.8
VI	0.45	6.2	100.0

Note. The sample size for the factor analysis was only 958, as subjects without Item Recognition Test scores were not included.

response latencies from the two verbally dependent tests (Self-Crediting Word Knowledge and Activities Interest Inventory) were the primary variables contributing to it. Factor IV represents self-assessment and self-confidence, and Factor VI represents response accuracy. It should be noted that the Self-Crediting Word Knowledge and Activities Interest Inventory response latencies loaded in opposite directions on Factor V, even though they are positively correlated with each other (see Table 7). One possible reason for the opposite factor loadings is that the Self-Crediting Word Knowledge Test score reflects verbal reasoning whereas the Activities Interest Inventory score reflects decisiveness.

The number and composition of the factors were not surprising, as the original BAT battery was designed to measure individual differences in three broad domains: psychomotor coordination, cognitive/perceptual speed and accuracy and personality/attitudinal characteristics. To a large extent the six factors identified reflect these ability domains.

These results suggest that a factor analytic approach may be useful for developing BAT composite indices similar to the AFOQT composites. If the BAT battery becomes an operational selection instrument, a composite measure would be easier to interpret than 17 summary scores.

IV. CONCLUSION

Test score profiles are needed in order to understand the performance characteristics of test instruments and interpret test scores. In particular, score profiles are useful for understanding the nature of the tests and the abilities being measured, detecting score irregularities, and making comparisons between applicable target groups. However, score profiles provide these benefits only for those groups on which they are based.

As previously noted, the ROTC and OTS score profiles presented in this paper should not be interpreted as normative data for USAF pilot training applicants, due to the fact that the subjects used in this study had already been preselected for pilot training on the basis of their academic performance, AFOQT scores and Flight Screening Program (FSP) performance. Further, these score profiles contain representatives from only two of the three major USAF commissioning sources (scores from US Air Force Academy [AFA] cadets were not available).

The eight BAT tests described in this report are being considered as adjuncts to the current USAF pilot candidate selection and classification procedure (Pilot Selection and Classification System, or PSACS). If PSACS is to be implemented operationally, true BAT score norms need to be developed for individuals representing the ROTC, OTS and AFA commissioning sources.

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APPENDIX A: DESCRIPTION OF AFOQT FORM O SUBTESTS AND COMPOSITE PROFILES

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Table A-1. **Composition of AFOQT Form O Subtests**

Subtest	No of items	Descriptive measures
Verbal Analogies	25	Ability to reason and recognize relationships between words
Arithmetic Reasoning	25	Ability to understand arithmetic relationships expressed as word problems
Reading Comprehension	25	Ability to read and comprehend paragraphs
Data Interpretation	25	Ability to interpret data from graphs and charts
Word Knowledge	25	Ability to understand written language through use of synonyms
Math Knowledge	25	Ability to use mathematical terms, formulas, and relationships
Mechanical Comprehension	20	Mechanical knowledge and understanding of mechanical functions
Electrical Maze	20	Spatial ability based on choice of a correct path through a maze
Scale Reading	40	Ability to read scales and dials
Instrument Comprehension	20	Ability to determine aircraft attitude from illustrations of flight instruments
Block Counting	20	Spatial ability through analysis of a three-dimensional representation of a set of blocks
Table Reading	40	Ability to read tables quickly and accurately
Aviation Information	20	Knowledge of general aeronautical concepts and terminology
Rotated Blocks	15	Spatial aptitude by visualizing and manipulating objects in space
General Science	20	Knowledge and understanding of scientific terms, concepts, principles, and instruments
Hidden Figures	15	Visual imagery and perceptual ability using a simple figure embedded in complex drawings

Table A-2. **Subtest Components of AFOQT Form O Composite Scores**

AFOQT Subtests	Verbal	Quantitative	Academic Aptitude	Navigator-Technical	Pilot
Verbal Analogies	X		X		X
Arithmetic Reasoning		X	X	X	
Reading Comprehension	X		X		
Data Interpretation		X	X	X	
Word Knowledge	X		X		
Math Knowledge		X	X	X	
Mechanical Comprehension				X	X
Electrical Maze				X	X
Scale Reading				X	X
Instrument Comprehension					X
Block Counting				X	X
Table Reading				X	X
Aviation Information					X
Rotated Blocks				X	
General Science				X	
Hidden Figures				X	

APPENDIX B: DESCRIPTIONS OF TESTS RECOMMENDED FOR ALTERATION OR REMOVAL FROM THE BAT BATTERY

Introduction

The following tests were included in the original BAT battery, but have been removed due to their poor predictive validity for USAF pilot training performance. Two of these tests, Decision-Making Speed, and the Automated Aircrew Personality Profiler have been modified and currently are being evaluated for inclusion in the BAT battery.

Dot Estimation

Two boxes containing an arbitrary number of dots are presented simultaneously on the screen. One of the two boxes contains one more dot than the other. The subject's task is to determine, as quickly as possible, which box has the greater number of dots. The subject is not told to count the dots in each box, but is told only to decide as quickly and accurately as possible which box has the greater number.

Reaction time and accuracy of response are recorded on each trial. This is the only test in the battery that has a fixed time limit (5 minutes, for a maximum of 55 trials). The psychological factor assessed by this test is impulsiveness/decisiveness.

Digit Memory

A string of four digits is presented simultaneously and in random order. The subject is instructed to respond by entering the digit string on a data entry keypad in the same order as presented. In addition to the recording of response accuracy and overall response time, a measure of perceptual speed is taken by forcing the subject to press a special ENABLE key that activates the data entry keypad buttons on each trial.

The most important attribute measured by this test is perceptual speed. There are 20 trials, which require about 5 minutes to complete.

Immediate/Delayed Memory

In this test, a sequence of digits is presented, and the subject is required to respond by indicating the digit that occurred either one or two digits previously. The one-back and two-back subtests have two parts. In the first part, the digits are presented for 1/2 second, followed by a 2-second interstimulus interval. In the second part, the interstimulus interval is 5 seconds. Thus, for both subtests, part one deals with "immediate" memory and part two with "delayed" memory.

There are 25 trials in each subtest (one- versus two-back) for each length of latency condition (2 versus 5 seconds) resulting in 100 trials. As with the other tests, response time and accuracy are recorded on each trial.

This test assesses continuous short-term memory storage and retrieval operations.

Decision-Making Speed

In this choice-reaction-time test, one of several alternative signals is presented to the subject. The subject is required to respond to the signal as quickly as possible. The critical manipulation

in this test is the amount of uncertainty that must be resolved in order to make the response decision. When an increased number of potential alternatives are introduced, greater uncertainty exists and the desision is made more slowly. This test consists of four subtests.

In subtest one, the subject knows both where and when a signal is to occur; in subtest two, the subject knows where but not when; in subtest three, when but not where; and finally, in subtest four, the subject knows neither where nor when. Each subtest has three parts. In part one, two potential signals and responses are defined. There are four potential signals and responses in part two and eight potential signals and responses in part three. Therefore, degree of uncertainty of signal is manipulated in three ways: location of occurrence, time of occurrence, and number of signals/responses. There are 12 trials within each part of each subtest, resulting in 144 trials (12x3x4). Response time and accuracy of response (correct/incorrect) are recorded for each trial.

The Decision-Making Speed Test assesses a variety of psychological factors. These include simple choice reaction time under varying degrees of information load and spatial and temporal uncertainty, as well as low-level cognitive and high-level sensory-perceptual motor involvement.

Risk-Taking

In this test, 10 boxes are presented in two rows of five boxes each. The subject is told that 9 of the 10 boxes contain a reward, whereas one of the boxes is a "disaster" box. If the selected box contains a payoff, the subject is allowed to keep it; but if the subject chooses the disaster box, all of the payoff earned on that trial is lost. The average number of boxes selected provides an index of the subject's tendency to take risks when making decisions.

Response time per choice and number of boxes chosen are recorded on each of 30 trials. Unknown to the subject, there is no "disaster box" (i.e., no risk) for 12 of the 30 trials. This method was used in order to obtain a clean measure of risk-taking behavior, as performance on the "disaster box" trials may be affected by chance.

Embedded Figures

A simple geometric figure and two complex geometric figures are presented to the subject. The subject's task is to decide which one of the two complex figures has the simple figure within it and to indicate a choice by pressing the button corresponding to the figure. Speed and accuracy of response are recorded on each of 30 trials. This test is designed to assess the psychological factor of field dependence/independence.

Automated Aircrew Personality Profiler

This is a questionnaire that examines the subject's attitudes and interests. The subject is given 66 questions, each requiring a choice between two alternatives. The subject is instructed not to spend time pondering responses, but to give the first natural answer as it comes. The questionnaire is a traditionally formulated personality inventory specially compiled in cooperation with the USAF School of Aerospace Medicine and targeted for aircrew selection and classification.

APPENDIX C: ILLUSTRATIONS OF SAMPLE BAT TEST ITEMS AND APPARATUS

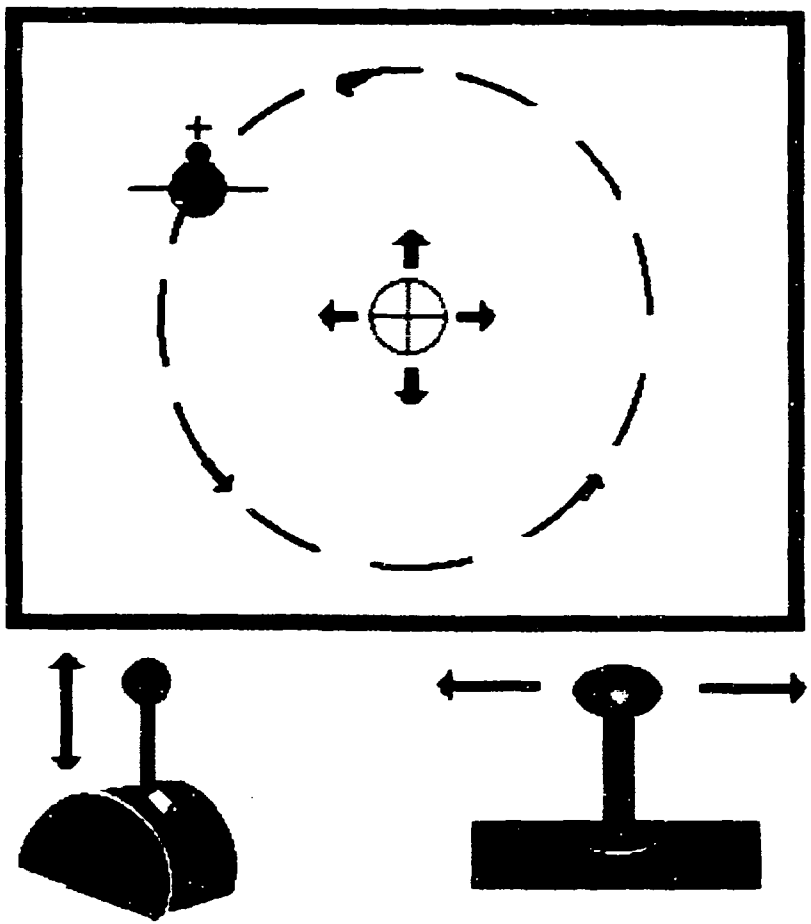

FIGURE C-1. TWO-HAND COORDINATION TEST

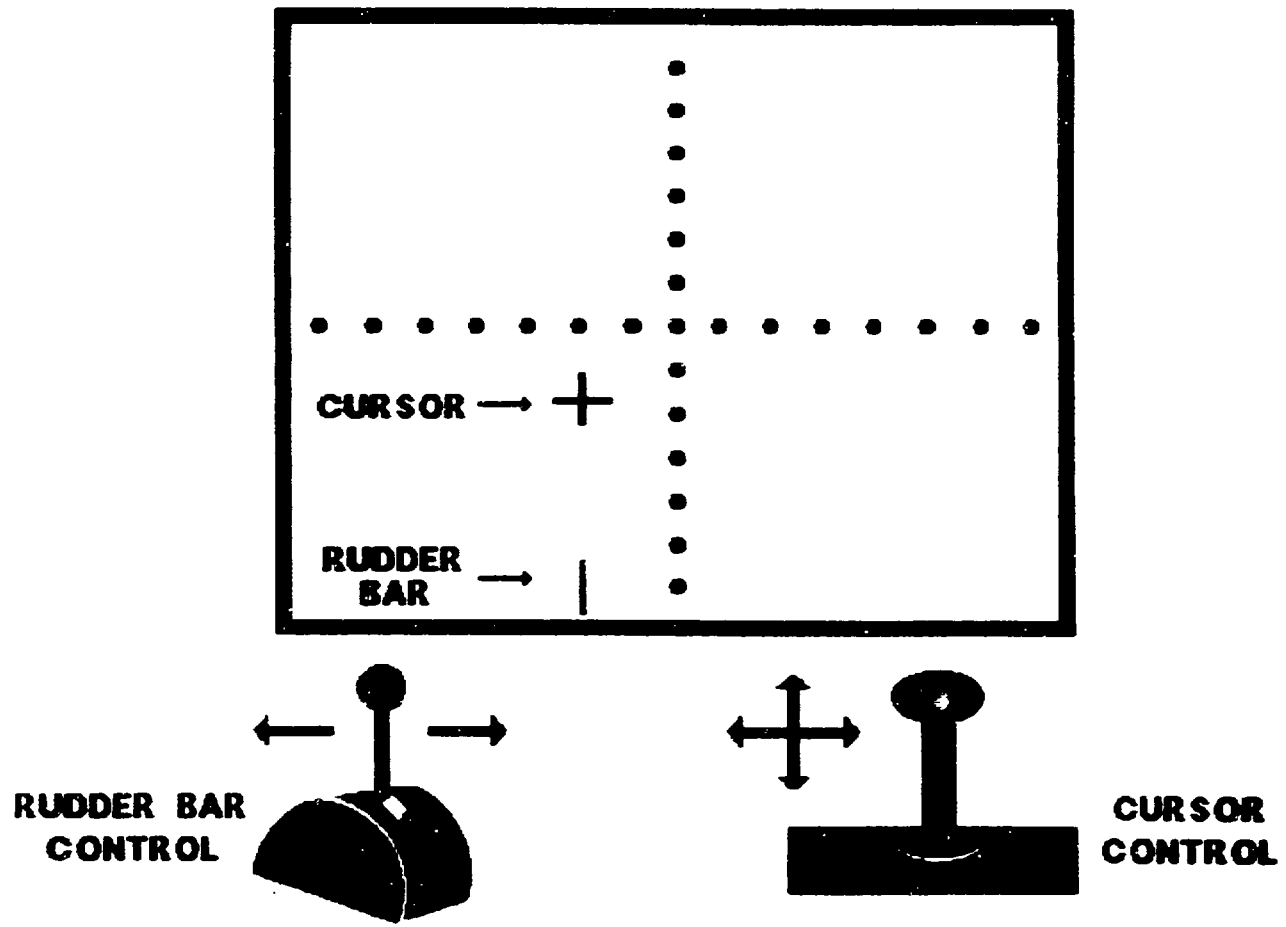

FIGURE C-2. COMPLEX COORDINATION TEST

	SAME	OR	DIFFERENT
PHYSICAL IDENTITY	AA		Aa
NAME IDENTITY	Aa		AH
CATEGORY IDENTITY	Ae		aH

FIGURE C-3. ENCODING SPEED TEST

SAME OR MIRROR IMAGE

FIGURE C-4. MENTAL ROTATION TEST

3 9 7 5 6 2 4

YES OR NO

FIGURE C-5. ITEM RECOGNITION TEST

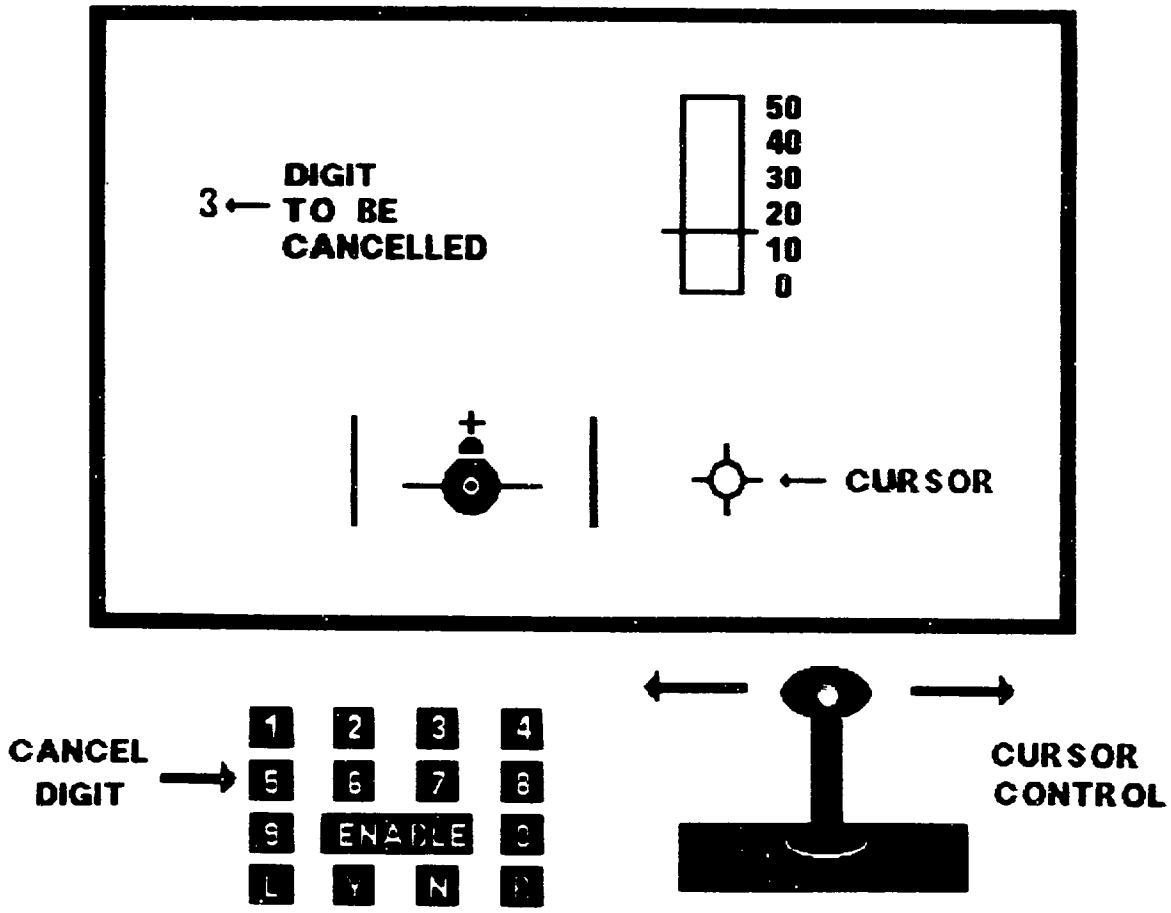

FIGURE C-6. TIME-SHARING TEST

WHICH OF THE WORDS BELOW MEAN
NEARLY THE SAME AS SIMPLE

1. CAREFUL
2. HARD
3. EASY
4. TOUGH
5. ANGRY

FIGURE C-7. SELF-CREDITING WORD KNOWLEDGE TEST

I WOULD RATHER:

1. PARTICIPATE IN A FOOTBALL GAME

2. OBSERVE A FOOTBALL GAME

FIGURE C-8. ACTIVITIES INTEREST INVENTORY

Figure C-9. **Basic Attributes Test Station.**

APPENDIX D: SCORING PROCEDURES FOR THE BAT BATTERY

Introduction

Scoring procedures for the Basic Attributes Test (BAT) battery rely on a combination of tracking error and difficulty, response speed, response accuracy and response choice, and in some instances, specially derived scores (e.g., regression slope and intercept, interaction terms). Details regarding scoring procedures for the eight validated BAT pilot candidate selection and classification tests are provided below.

Two-Hand Coordination

Normally, this test would provide two tracking error scores (X1 tracking error [horizontal] and Y1 tracking error [vertical]). However, due to an error in the scoring algorithm, the Y1 tracking error score was accumulated incorrectly for most of the subjects in this study. As a result, Y1 tracking error is not reported in the data summaries in this report, but is described here for completeness:

X1 Tracking Error (PS2X1). Cumulative tracking error for the X1 axis (horizontal displacement of the cross from the target) for the final 2 minutes of the test period.

Y1 Tracking Error (PS2Y1). Cumulative tracking error for the Y1 axis (vertical displacement of the cross from the target) for the final 2 minutes of the test period.

Complex Coordination

X2 Tracking Error (PS2X2). Cumulative tracking error for the X2 axis (horizontal displacement of the cross from the center of the screen) for the final 2 minutes of the test period.

Y2 Tracking Error (PS2Y2). Cumulative tracking error for the Y2 axis (vertical displacement of the cross from the center of the screen) for the final 2 minutes of the test period.

Z2 Tracking Error (PS2Z2). Cumulative tracking error for the Z2 axis (displacement of the rudder bar from the center point at the bottom of the screen) for the final 2 minutes of the test period.

Encoding Speed

Several of the tests in the BAT battery rely on response latencies (in milliseconds) as an indicator of test performane. The standard scoring technique for tests of this type uses data only from trials that were answered correctly when computing summary scores. For the BAT battery, this procedure includes the following tests: Encoding Speed, Mental Rotation, Item Recognition, Time Sharing and Self-Crediting Word Knowledge.

The following scores are used to evaluate performance on the Encoding Speed Test:

Average Response Time (ENCRT). Average response time in milliseconds based on all trials answered correctly.

Percent Correct (ENCPER). Percent correct.

Average Response Time x % Correct (ENCINT). This is a response time by percent correct interaction term: [Subject's average response time - grand mean average response time] x [Subject's percent correct - grand mean percent correct]).

Mental Rotation

Average Response Time (MRTRT). Average response time in milliseconds based on all trials answered correctly.

Standard Deviation (MRTSD). Standard deviation of response time in milliseconds based on all trials answered correctly.

Percent Correct (MRTPER). Percent correct.

Item Recognition

Average Response Time (ITMRT). Average response time in milliseconds based on all trials answered correctly.

Slope (ITMSLP). This score represents a regression slope for the best-fitting line for average response time to digit strings of differing lengths (1, 2, 3, 4, 5 or 6 digits).

Intercept (ITMICP). This score represents a regression intercept for the best-fitting line for average response time to digit strings of different lengths (1, 2, 3, 4, 5 or 6 digits).

Percent Correct (ITMPER). Percent correct.

Time-Sharing

Slope (Tracking Difficulty) (TMSSLP). Average tracking difficulty was computed for each subject during each minute of the practice trials (minutes 1-10). This score represents a regression slope based on the best-fitting line describing the eight average tracking difficulty scores for minutes 3-10 of this test (learning rate on the tracking task).

Intercept (Tracking Difficulty) (TMSICP). This score represents a regression intercept based on the best-fitting line describing the eight 1-minute average tracking difficulty scores for minutes 3-10 of the test.

Average Tracking Difficulty (TMSDIF). Average tracking difficulty achieved during minutes 11-19.

Average Response Time (TMSRT). Average response time in milliseconds to cancel the digits that appear during the dual-task trials (minutes 11-16).

Average Response Time x Tracking Difficulty (TMSRTD). This is a response time by tracking difficulty interaction term based on performance during the dual-task trials (minutes 11-16). It is generated in a manner similar to that for ENCINT (see above).

Self-Crediting Word Knowledge

Average Response Time (WKART). Average response time in milliseconds based on all trials answered correctly.

Percent Correct (WKAPER). Percent correct.

Average Response Time x Percent Correct (WKAINT). This is a response time by percent correct interaction term. It is generated in a manner similar to that for ENCINT (see above).

Bet (WKABET). This score is the average bet the subject made prior to each of the three blocks of trials. It reflects the subject's self-confidence regarding his/her expected performance on this test. Higher scores reflect greater self-confidence.

Activities Interest Inventory

Number of High-Risk Choices (AIAHIR). This score indicates the number of high-risk choices made by the subject.

Average Response Time (AIART). Average response time across all 81 trials (in milliseconds).

Table D-1. **Reliability Estimates for BAT Performance Scores**

Test score	N	No of scores[a]	Cronbach's alpha	Reference
Two-Hand Coordination:				
X1 Tracking Error	233	10	.94	Mercatante, 1988
Complex Coordination:				
X2 Tracking Error	233	10	.95	Mercatante, 1988
Y2 Tracking Error	233	10	.99	
Z2 Tracking Error	233	10	.94	
Encoding Speed:				
Response Time	2,219	96	.96	Carretta, 1988a
Response Accuracy	2,219	96	.71	
Mental Rotation:				
Response Time	1,685	72	.97	Not previously
Response Accuracy	1,685	72	.90	reported
Item Recognition:				
Response Time	1,500	48	.95	Not previously
Response Accuracy	1,500	48	.54	reported
Time-Sharing:				
Tracking Difficulty	1,130	19	.96	Carretta, 1987b
Self-Crediting Word Knowledge:				
Response Time	1,992	30	.89	Carretta & Siem,
Response Accuracy	1,992	30	.65	1988
Activities Interest Inventory:				
Response Time	1,992	81	.95	Carretta & Siem,
Response Choice	1,992	81	.86	1988

[a]For the Two-Hand Coordination Test, Complex Coordination Test and Time-Sharing Test, "Scores" refer to summed tracking performance over time. For the other tests, "Scores" refer to test items.

* U. S. GOVERNMENT PRINTING OFFICE: 1990--761-051/20012

SUPPLEMENTARY

INFORMATION

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ERRATA

Carretta, T.R. (1990, March). Basic Attributes Test (BAT): A preliminary comparison between Reserve Officer Training Corps (ROTC) and Officer Training School (OTS) pilot candidates (AFHRL-TR-89-50, AD-A224 093). Brooks AFB, TX: Manpower and Personnel Division, Air Force Human Resources Laboratory.

Attached are corrected pages 7, 8, 9, 10, 11, and 12 to replace those printed in the original technical report.

ESTHER M. BARLOW
Technical Editing

These score differences do not influence the comparative likelihood of selection for pilot training for members of the two groups, as ROTC and OTS pilot training candidates are evaluated by separate selection boards.

Basic Attributes Test

Descriptive Measures

For all of the tests in the BAT battery, tracking error scores, response latencies, and response choice/accuracy are used to assess individual differences in performance. These types of scores tend to exhibit extremely skewed, non-normal distributions. It is difficult to interpret summary statistics from such distributions as both means and standard deviations tend to be distorted by extreme scores. To reduce this effect, all BAT scores that were more than three standard deviations from the mean were recoded to be exactly three standard deviations from the mean. In most instances this affected only a few scores; however, up to 8.85% of the scores for a test were affected. Even after recoding, some distributions were skewed. See Tables 4 and 5 for detailed descriptions of the ROTC and OTS BAT score distributions. Estimates of the internal consistency of the test items are provided in Appendix D (Table D-1).

ROTC Versus OTS Comparisons

Although the ROTC and OTS groups exhibited differences in performance on the BAT battery, the direction of the differences did not clearly favor one group over the other. Table 6 summarizes comparisons between the ROTC and OTS group mean scores.

The two groups did not differ in a consistent manner in tracking performance. The OTS group had marginally lower X2 tracking error scores on the Complex Coordination Test (M ROTC = 9,497.5, M OTS = 8,421.0; t [1053] = 2.29, $p \leq .05$) However, the ROTC group performed at a higher average tracking difficulty on the compensatory tracking task used in the Time-Sharing Test (M ROTC = 263.7, M OTS = 256.2; t [1053] = 3.19, $p \leq .01$).

Results from the other six tests also were mixed. OTS subjects made quicker responses on the Mental Rotation average response time (M ROTC = 988.5 milliseconds (ms), M OTS = 924.5 ms; t (1053) = 3.08, $p \leq .01$) whereas ROTC subjects were quicker on the Time-Sharing average response time (M ROTC = 1,202.8 ms, M OTS = 1,238.5 ms; t [1053] = -2.66, $p \leq .01$). OTS subjects achieved a higher level of accuracy than did the ROTC subjects on three of the cognitive abilities tests (Encoding Speed, Mental Rotation and Item Recognition), although this difference was statistically significant for only the Item Recognition Test (M ROTC = 94.3% correct, M OTS = 95.1% correct; t [957] = -2.81, $p \leq .01$).

On the two personality-type BAT tests, ROTC subjects required more time to make decisions and were less willing to take risks than were the OTS subjects. For instance, on the Self-Crediting Word Knowledge Test, a test of self-confidence, ROTC subjects took longer to make decisions (average response time: M ROTC = 7,812.2 ms, M OTS = 7,592.5 ms; t [1053] = 2.30, $p \leq .05$) and had lower expectations about their performance (bet less; M ROTC = 38.0, M OTS = 40.2; t [1053] = -4.26, $p \leq .01$) than did their OTS counterparts. In addition, the ROTC subjects were less accurate on this test (M ROTC = 63.7% correct, M OTS = 67.2% correct; t [1053] = -5.30, $p \leq .01$). One explanation for the group differences in performance on this test may reside in the nature of the test items. The Self-Crediting Word Knowledge Test is essentially a vocabulary test in which the subject makes predictions about his/her performance. In that the ROTC subjects had lower scores on the AFOQT vocabulary subtest (Word Knowledge), their poorer performance and lower expectations on the Self-Crediting Word Knowledge Test are not surprising. If self-confidence levels had been assessed using another ability domain, the results might have been different.

Table 4. **Descriptive Statistics for ROTC BAT Battery Scores**

Test score	Mean	SD	Minimum	Maximum	Skew	Kurtosis	% of extreme scores recoded
Two-Hand Coordination:							
X1 Tracking Error	11,646.4	4,526.4	5,265.0	35,000.0	1.65	4.40	0.57
Complex Coordination:							
X2 Tracking Error	9,497.5	7,258.2	832.0	26,525.0	1.11	0.02	8.85
Y2 Tracking Error	8,781.3	9,258.2	399.0	35,000.0	1.81	2.34	8.20
Z2 Tracking Error	7,129.1	6,154.6	657.0	35,000.0	2.33	6.15	0.98
Encoding Speed:							
Avg RT (ms) - correct responses	738.0	149.4	446.1	1,150.0	0.80	0.18	1.97
Percent Correct (%)	90.9	4.7	70.8	100.0	-0.38	0.36	0.00
Avg RT x % Correct	3,733.3	8,242.6	-18,000.0	24,000.0	0.38	0.74	5.90
Mental Rotation:							
SD RT (ms) - correct responses	407.0	211.3	111.4	1,250.0	1.64	3.10	0.98
Avg RT (ms) - correct responses	988.5	283.2	355.4	1,800.0	0.96	0.68	1.97
Percent Correct (%)	90.2	8.4	65.0	100.0	-1.57	2.18	5.57
Item Recognition:							
Avg RT (MS) - correct responses	861.6	201.2	554.6	1,450.0	0.88	0.39	1.91
Slope (RT)	-18.5	20.6	-80.0	40.0	-0.16	1.02	1.91
Intercept (RT)	927.6	229.4	564.4	1,700.0	0.89	0.63	0.38
Percent Correct (%)	94.3	4.4	80.0	100.0	-1.15	1.30	1.15
Time-Sharing:							
Slope (Tracking Difficulty)	6.4	11.1	-25.0	35.0	0.20	0.68	4.59
Intercept (Tracking Difficulty)	294.3	101.3	0.0	623.7	-0.53	1.06	1.71
Avg Tracking Difficulty	263.7	36.5	150.0	335.6	-0.68	0.60	1.43
Avg RT (ms)	1,202.8	188.2	863.6	1,800.0	1.16	1.61	2.29
Avg RT x Tracking Difficulty	300,878.5	55,924.8	150,000.0	450,000.0	0.34	0.67	3.43

Table 4. (Concluded)

Test score	Mean	SD	Minimum	Maximum	Skew	Kurtosis	% of extreme scores recoded
Self-Crediting Word Knowledge:							
Avg RT (ms) - correct responses	7,812.2	1,596.6	3,942.0	11,500.0	0.20	-0.33	1.97
Percent Correct (%)	63.7	10.1	30.0	96.7	0.02	0.39	0.00
Avg RT x % Correct	-2,129.6	16,333.5	-45,000.0	45,000.0	-0.28	1.70	5.90
Bet	38.0	8.1	13.3	50.0	-0.31	-0.37	0.00
Activities Interest Inventory:							
N High-Risk Choices	50.0	9.2	25.0	74.0	-0.07	-0.39	0.00
Avg RT (ms)	4,275.5	905.2	2,409.0	7,000.0	0.03	-0.04	1.31

Note. The number of ROTC subjects tested was 350 for all tests except Item Recognition, which had only 261 subjects.

Table 5. **Descriptive Statistics for OTS BAT Battery Scores**

Test score	Mean	SD	Minimum	Maximum	Skew	Kurtosis	% of extreme scores recoded
Two-Hand Coordination:							
X1 Tracking Error	11,531.8	5,293.7	2,461.0	35,000.0	1.10	1.93	0.28
Complex Coordination:							
X2 Tracking Error	8,421.0	6,967.4	228.0	26,525.0	1.29	0.71	5.25
Y2 Tracking Error	7,776.7	8,559.4	636.0	35,000.0	2.13	3.84	5.82
Z2 Tracking Error	7,303.8	7,000.3	660.0	35,000.0	2.34	5.68	2.41
Encoding Speed:							
Avg RT (ms) - correct esponses	743.9	137.0	480.9	1,150.0	0.94	0.70	1.84
Percent Correct (%)	91.0	4.4	75.0	100.0	-0.33	-0.30	0.00
Avg RT x % Correct	3,104.1	7,462.9	-18,000.0	24,000.0	0.63	1.55	3.83
Mental Rotation:							
SD RT (ms) - correct responses	449.0	268.0	115.8	1,250.0	1.38	1.33	2.84
Avg RT (ms) - correct responses	924.5	333.5	88.3	1,800.0	0.24	0.48	2.27
Percent Correct (%)	90.7	8.4	65.0	100.0	-1.62	2.19	3.69
Item Recognition:							
Avg RT (ms) - correct responses	868.1	216.2	454.9	1,450.0	0.88	0.42	2.58
Slope (RT)	-18.3	23.6	-80.0	40.0	-0.13	0.61	3.44
Intercept (RT)	934.2	252.0	460.5	1,700.0	1.06	1.04	2.01
Percent Correct (%)	95.1	4.0	80.0	100.0	-1.11	1.25	0.43
Time-Sharing:							
Slope (Tracking Difficulty)	6.5	9.9	-20.8	35.0	0.27	0.35	1.13
Intercept (Tracking Difficulty)	283.6	94.9	0.0	517.1	0.52	0.48	0.71
Avg Tracking Difficulty	256.2	35.9	150.0	337.8	-0.49	0.02	0.85
Avg RT (ms)	1,238.5	213.3	779.5	1,800.0	0.80	0.27	2.84
Avg RT x Tracking Difficulty	300,482.4	59,546.2	150,000.0	450,000.0	0.45	0.12	3.26

Table 5. (Concluded)

Test score	Mean	SD	Minimum	Maximum	Skew	Kurtosis	% of extreme scores recoded
Self-Crediting Word Knowledge:							
Avg RT (ms) - correct responses	7,592.5	1,386.0	3,586.5	11,500.0	0.18	-0.09	0.57
Percent Correct (%)	67.2	10.0	36.7	96.7	0.18	0.15	0.00
Avg RT x % Correct	-3,365.1	14,231.9	-45,000.0	45,000.0	-0.62	1.86	2.41
Bet	40.2	7.9	10.0	50.0	-0.64	0.04	0.00
Activities Interest Inventory:							
N High-Risk Choices	51.7	9.7	23.0	76.0	0.11	-0.38	0.00
Avg RT (ms)	4,566.4	964.7	2,197.0	7,000.0	0.26	-0.30	1.70

Note. The number of OTS subjects was 705 for all tests except Item Recognition, which had only 697 subjects.

Table 6. **Summary of BAT Comparisons between ROTC and OTS Samples**

Test score	ROTC (N = 350) Mean	ROTC (N = 350) SD	OTS (N = 705) Mean	OTS (N = 705) SD	Two-tailed t-test
Two-Hand Coordination:					
X1 Tracking Error	11,646.4	4,526.4	11,531.8	5,293.7	0.35
Complex Coordination:					
X2 Tracking Error	9,497.5	7,599.6	8,421.0	6,967.4	2.29*
Y2 Tracking Error	8,781.3	9,258.2	7,776.7	8,559.4	1.75
Z2 Tracking Error	7,129.1	6,154.6	7,303.8	7,000.3	-0.40
Encoding Speed:					
Avg RT (ms) - correct responses	738.0	149.4	743.9	137.0	-0.63
Percent Correct (%)	90.9	4.7	91.0	4.4	-0.37
Avg RT x % Correct	3,733.3	8,242.6	3,104.1	7,462.9	1.24
Mental Rotation:					
Standard Deviation RT (ms) - correct responses	407.0	211.3	449.0	268.0	-2.56*
Avg RT (ms) - correct responses	988.5	283.2	924.5	333.5	3.08**
Percent Correct (%)	90.2	8.4	90.7	8.4	-1.00
Item Recognition:					
Avg RT (ms) - correct responses	861.6	201.2	868.1	216.2	-0.42
Slope (RT)	-18.5	20.6	-18.3	23.6	-0.11
Intercept (RT)	927.6	229.4	934.2	252.0	-0.37
Percent Correct (%)	94.3	4.4	95.1	4.0	-2.81**
Time-Sharing:					
Slope (Tracking Difficulty)	6.4	11.1	6.5	9.9	-0.13
Intercept (Tracking Difficulty)	294.3	101.3	283.6	94.9	1.69
Avg Tracking Difficulty	263.7	36.5	256.2	35.9	3.19**
Avg RT (ms)	1,202.8	188.2	1,238.5	213.3	-2.66**
Avg RT x Tracking Difficulty	300,878.5	55,924.8	300,482.4	59,546.2	0.10
Self-Crediting Word Knowledge:					
Avg RT (ms) - correct responses	7,812.2	1,596.6	7,592.5	1,386.0	2.30*
Percent Correct (%)	63.7	10.1	67.2	10.0	-5.30**
Avg RT x % Correct	-2,129.6	16,333.5	-3,365.1	14,231.9	1.26
Bet	38.0	8.1	40.2	7.9	-4.26**
Activities Interest Inventory:					
N High-Risk Choices	50.0	9.2	51.7	9.7	-2.66**
Avg RT (ms)	4,275.5	905.2	4,566.4	964.7	-4.71**

Note. The number of subjects for the Item Recognition test is 261 for the ROTC group and 697 for the OTS group.

*$p \leq .05$.

**$p \leq .01$.