

# **Dynamic and Interactive Computerized Tests of Cognitive, Perceptual, and Psychomotor Abilities:**

**A Comparison of a Computerized Test Battery with the ASVAB in Predicting Training and Job Performance Among Airmen and Sailors.**

*Ray Morath, Brian Cronin, & Michael Heil*

# OVERVIEW OF AT-SAT

- In the mid-late 1990's a team of researchers developed AT-SAT, a dynamic and interactive battery of computerized tests that is currently being used to select FAA air traffic control specialists.
- AT-SAT was designed to measure the cognitive, perceptual, and psychomotor abilities critical to successful air traffic controller performance.
- An empirical, concurrent validation study using a sample of over 1,000 air traffic control specialists produced evidence of high criterion-related validity.

# CURRENT RESEARCH WITH AT-SAT

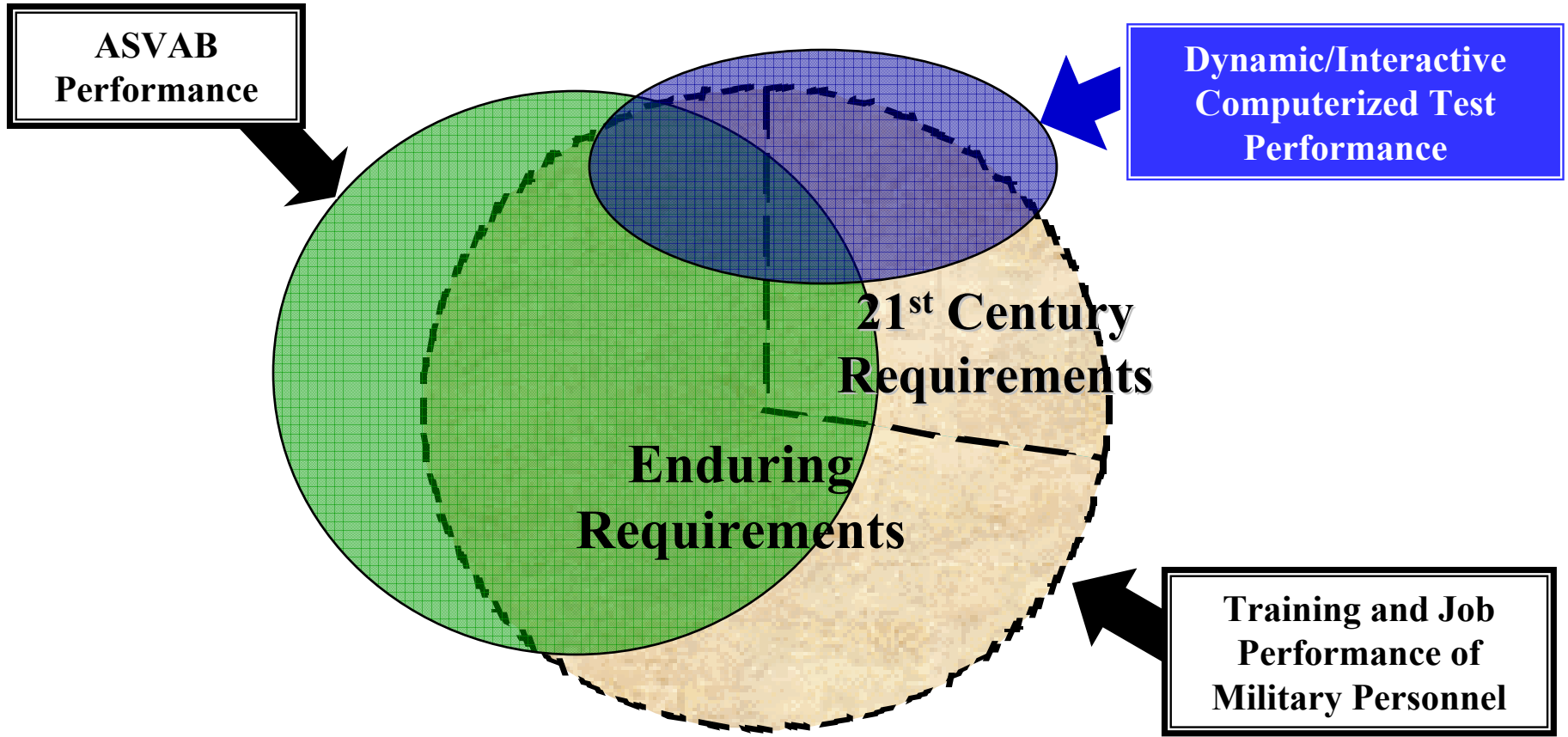
- Caliber, FAA CAMI, and HumRRO recently developed a parallel form of the AT-SAT battery and are currently conducting an equating study to ensure that the new form is psychometrically equivalent to the original form.
- The equating study analysis will be based on data from approximately 1,500 Air Force and Navy personnel who are about to enter technical training programs for their assigned military positions.
- We will compare AT-SAT and ASVAB scores to investigate whether or not AT-SAT adds incremental validity over ASVAB in predicting variability in training and job performance.

# AT-SAT & MILITARY PERSONNEL PERFORMANCE

- Many of the abilities measured by AT-SAT are also required for officers, non-commissioned officers, and enlisted personnel performance:
  - ✓ e.g., working memory, situational awareness; problem solving; planning; rule application; dynamic visual-spatial; perceptual speed.
- Dynamic and interactive computerized tests may be more appropriate measures of some future job requirements (e.g., perceiving, assessing, and responding to electronic/digitalized information) than traditional paper-and-pencil tests.



# HYPOTHESIZED MODEL



# ASVAB vs. AT-SAT

## ASVAB

### Tests and Descriptions

- **Paragraph Comprehension:** Reading comprehension test
- **Word Knowledge:** Vocabulary test using words embedded in sentences or synonyms
- **General Science:** Knowledge test physical and biological sciences
- **Arithmetic Reasoning:** Arithmetic word problem test
- **Math Knowledge:** Test of algebra, geometry, fractions, decimals, and exponents
- **Mechanical Comprehension:** Knowledge test of mechanical and physical principles
- **Auto and Shop Information:** Knowledge test of automobiles, shop practices, tools, and tool use
- **Electronic Information:** Knowledge test of electronics, radio, and electrical principles
- **Assembling Objects:** Spatial ability



# ASVAB vs. AT-SAT

## AT-SAT

### Sample of Personnel Requirements Measured

- **Prioritization:** The ability to identify activities that are most critical and require immediate attention.
- **Situational Awareness:** Being cognizant of all information within a four-dimensional space (i.e., separation standards plus time).
- **Planning:** The ability to determine the appropriate course(s) of action to take in any given situation.
- **Execution:** The ability to take timely action in order to avoid problems and to solve existing problems.
- **Dynamic Visual-Spatial:** Ability to deal with dynamic visual movement
- **Intermediate-Term Memory:** The ability to remember pertinent information over a 1-10 minute period Visual-Spatial Reasoning
- **Visualization:** The ability to translate material into a visual representation of what is currently occurring.
- **Visual Scanning:** The ability to quickly and accurately search for information on a computer screen, radar scope, or computer printout
- **Thinking Ahead:** The ability to anticipate or recognize problems before they occur and to develop plans to avoid problems.
- **Time sharing/Multi-tasking:** The ability to perform two or more job activities at the same time.
- **Rule Inference:** The ability to efficiently apply transformational rules inferred from the complete portions of the stimulus array to the incomplete portion of the array.
- **Perceptual Speed & Accuracy:** Ability to perceive visual information quickly and accurately and to perform simple processing tasks with (e.g., comparisons).
- **Decisiveness:** The ability to make effective decisions in a timely manner.



Source: Morath, Quartetti, Bayless, & Archambault, 1999

# ELEMENTS OF ATSAT

- ATSAT is a dynamic/interactive computerized test battery that has 8 subtests. For the purposes of this presentation, four of the subtests will be highlighted.
  - ✓ Subtest 1: Letter Factory
  - ✓ Subtest 2: Air Traffic Scenarios
  - ✓ Subtest 3: Analogies
  - ✓ Subtest 4: Scan
- The requirements identified in the following slides are believed to be directly related to the digitization of military performance requirements—specifically within the areas of technical training performance and tactical performance when military personnel must quickly perceive and assess electronic/digital displays of information and data (often dynamic and interactive) and respond appropriately in a timely manner.



# LETTER FACTORY TEST

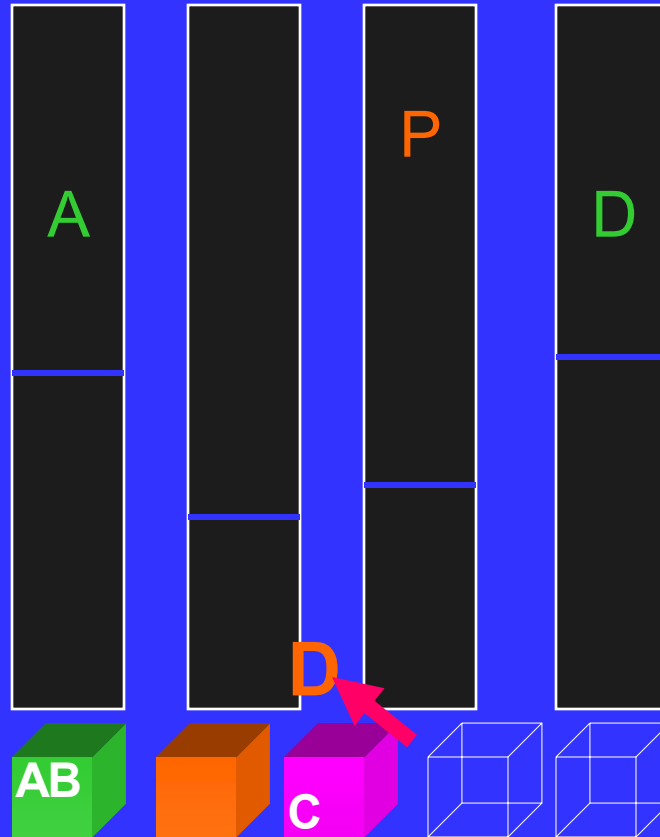
## Job Requirements Measured

- Time sharing/Multi-tasking
- Tolerance for High Intensity
- Situational Awareness
- Planning
- Execution
- Prioritization
- Thinking Ahead
- Decisiveness
- Immediate-term Memory
- Short-term Memory
- Scanning
- Concentration
- Perceptual Speed and Awareness
- Dynamic Visual-Spatial
- Projection
- Attention to Detail
- Recall from Interruption
- Sustained Attention



# LETTER FACTORY TEST

Belt A Belt B Belt C Belt D



Quality Control

Order Boxes

# **LETTER FACTORY TEST- SITUATIONAL AWARENESS QUESTIONS**

**Which boxes should be in the loading area in order to correctly place all the letters on the belts?**

- 1. One purple box and one orange box**
- 2. One green box, one purple box, and one orange box**
- 3. Two purple boxes, one green box, and one orange box**
- 4. Two green boxes, one orange box, and one purple box**

# AIR TRAFFIC SCENERIOS

## Job Requirements Measured

- Translating Information
- Dynamic Visual-Spatial
- Execution
- Scanning
- Decisiveness
- Composure
- Reasoning
- Situational Awareness
- Movement Detection
- Tolerance for High Intensity
- Prioritization
- Planning
- Thinking Ahead
- Projection
- Perceptual speed and accuracy



# AIR TRAFFIC SCENERIOS

The image displays an air traffic control interface. The main radar display shows two aircraft, 'e' and 'f', represented as semi-circles. Aircraft 'e' is at the top center, and aircraft 'f' is at the bottom center. A white arrow points to aircraft 'e'. Various flight instructions are shown in green text: 'F3f →' (top left), 'F4e ←' (top center), 'F2e →' (center, with arrow), 'F4B ↓' (center right), '← F4D' (left), 'F4f ↓' (bottom left), 'S1A ↑' (bottom center), and 'F1B ↑' (bottom right). Two red boxes with white text are positioned near aircraft 'f': 'M4C ↘' and 'F4B ↑'. The interface is divided into four quadrants labeled A, B, C, and D.

**Control Panel:**

- Landing Headings:** e →, f →
- Heading:** REPEAT, 7 0 1, 6 2, 5 4 3
- Speed:** F, M, S
- Level:** 4, 3, 2, 1
- Distance:** 5 Miles, 180, 105
- Pilot Readback:** Roger, Level 4
- Sector Message:** [Empty box]

# ANALOGY TEST

## Job Requirements Measured

- Rule Application
- Visual-Spatial Reasoning
- Rule Inference
- Confirmation
- Reasoning
- Perceptual Speed and Accuracy
- Verbal Reasoning



# ANALOGY TEST

Water: Liquid

Ice: ?

Gas  
(1)

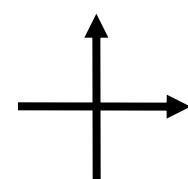
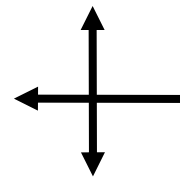
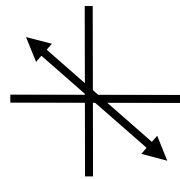
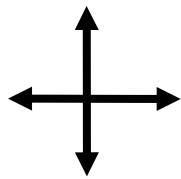
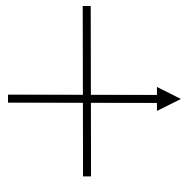
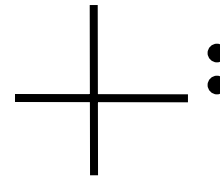
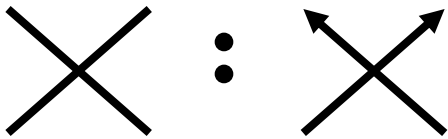
Cube  
(2)

Solid  
(3)

Oxygen  
(4)

Freeze  
(5)

# VISUAL ANALOGY TEST





# SCAN TEST

## Job Requirements Measured

- Scanning
- Perceptual Speed and Accuracy
- Dynamic Visual-Spatial
- Tolerance for High-Intensity



# SCAN TEST

B12  
810

T65  
120

K23  
250

F75  
560

V41  
610

C20  
390

P45  
580

Y85  
710

Type the identification numbers contained in the data block with lower line numbers falling beyond the range (360-710): \_\_\_\_\_

# CONCLUSIONS

- The influence of digitization on military performance requirements—specifically within the areas of technical training performance and tactical and technical performance, highlight the need for new, dynamic and interactive methods, such as the AT-SAT, to measure the abilities associated with these changing requirements.
- Many of the cognitive, perceptual, and psychomotor abilities measured by AT-SAT are also required by officers, NCOs, and enlisted personnel in the military across a wide range of training and operational settings that require interaction with electronic stimuli.
- Tests similar to AT-SAT may be used in post-enlistment settings to better assess job-specific abilities so that more informed decisions can be made regarding assignment and training.
- These tests may also be used to measure complex cognitive abilities required by other industries and professions.

# CONCLUSIONS

- For more information, please contact Ray Morath [rmorath@caliber.com](mailto:rmorath@caliber.com) or Brian Cronin [bcronin@caliber.com](mailto:bcronin@caliber.com). Thank you for your time.



# AT-SAT CONCURRENT CRITERION-RELATED VALIDITY

	<u>N</u>
.76 with composite criterion	1029
.78 with CBPM	1032
.38 with ratings	1053

Validity corrected for shrinkage, restriction in range, and unreliability in criterion

# AT-SAT & MILITARY PERSONNEL PERFORMANCE

- Many of the abilities measured by AT-SAT are also required for officers, non-commissioned officers, and enlisted personnel performance (Campbell, Knapp, & Heffner, 2002; Horey, Cronin, Morath, Franks, Cassella, & Fallesen, in press; Noble & Fallesen, 2000; Rumsey, 1995):
  - ✓ e.g., working memory, situational awareness; problem solving; planning; rule application; dynamic visual-spatial; perceptual speed
- Dynamic and interactive computerized tests may be more appropriate measures of some Future Force job requirements (e.g., perceiving, assessing, and responding to electronic/digitalized information) than traditional paper-and-pencil tests.

