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Research Report 1510

Assessing the Impact of Psychomotor and Leadership Selection Tests on the Excellence in Armor Program

Scott E. Graham

March 1989

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EDGAR M. JOHNSON
Technical Director

JON W. BLADES
COL, IN
Commanding

Technical review by

Millicent H. Abel
Clinton Walker

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As part of the Skills Selection and Sustainment (S^3) program, this research evaluated the potential effectiveness of spatial, psychomotor, and leadership scales as additional selection criteria for the Excellence in Armor (EIA) program. The S^3 predictor tests were administered to 1,642 One Station Unit Training (OSUT) soldiers at the Fort Knox reception station. In addition, 479 19K (M1 tank crewmen) OSUT soldiers were given an engagement tank gunnery test on the high-fidelity Institutional Conduct of Fire Trainer (I-COFT). The I-COFT test included offensive and defensive engagements fired in normal and degraded operational modes. The primary analysis evaluated I-COFT speed and accuracy as a function of S^3 spatial/psychomotor scores. The S^3 spatial/psychomotor tests were a strong predictor of simulated tank gunnery performance, yielding a correlation of .54 with I-COFT speed/accuracy. The 2-1/2-month interval between the predictor and criterion tests suggests that the relationship should remain stable over time, and the relationship shrank only slightly when the EIA soldiers were given additional training. The results indicate that (Continued)

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22a. NAME OF RESPONSIBLE INDIVIDUAL
Scott E. Graham

22b. TELEPHONE *(Include Area Code)*
(502) 624-2613

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PERI-IK

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including the S^3 tests in the EIA selection process would result in EIA graduates with stronger gunnery skills.

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Assessing the Impact of Psychomotor and Leadership Selection Tests on the Excellence in Armor Program

Scott E. Graham

Field Unit at Fort Knox, Kentucky
Donald F Haggard, Chief

Training Research Laboratory
Jack H. Hiller, Director

U.S. Army Research Institute for the Behavioral and Social Sciences
5001 Eisenhower Avenue, Alexandria, Virginia 22333-5600

Office, Deputy Chief of Staff for Personnel
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Education and Training

FOREWORD

The Commanding General, U.S. Army Training and Doctrine Command (TRADOC), wants to ensure that combat soldiers possess the necessary skills to maximize the effectiveness of their high-technology weapon systems. He has thereby directed the proponent schools to develop accelerated initial-entry training programs modeled after the successful Excellence in Armor (EIA) program. Furthermore, he has urged the schools to select for the accelerated programs only those soldiers who have outstanding gunnery and leadership potential.

As part of the TRADOC-directed Skills Selection and Sustainment (S^3) program, the U.S. Army Armor Center and School is going to include validated selection tests in the EIA selection process, including an S^3 test battery. The S^3 selection tests, developed by the U.S. Army Research Institute as part of Project A, include psychomotor, spatial, and leadership scales that have previously been shown to predict tank gunnery performance and Noncommissioned Officer potential. The current research assesses the utility and impact of the S^3 selection tests as additional selection criteria for the EIA program.

The research was conducted by the U.S. Army Research Institute's Fort Knox Field Unit as Technical Advisory Service to TRADOC, with the results briefed to the Commanding General, U.S. Army Armor Center and School, in September 1988. The results show the S^3 test to be highly predictive of simulated gunnery performance and suggest that the inclusion of the tests in the EIA selection process would result in soldiers with stronger leadership and gunnery abilities.

EDGAR M. JOHNSON
Technical Director

ASSESSING THE IMPACT OF PSYCHOMOTOR AND LEADERSHIP SELECTION TESTS ON THE EXCELLENCE IN ARMOR PROGRAM

EXECUTIVE SUMMARY

Requirement:

As part of the Skills Selection and Sustainment (S^3) program, the research evaluated the potential effectiveness of spatial, psychomotor, and leadership tests as additional selection criteria for the Excellence in Armor (EIA) program. The EIA program identifies outstanding initial-entry soldiers and gives them accelerated training as part of One Station Unit Training (OSUT).

Procedure:

The S^3 predictor tests were administered to 1,642 OSUT soldiers at the Fort Knox reception station. In addition, 479 19K (M1 tank crewmen) OSUT soldiers were given a 35-engagement tank gunnery test on the high-fidelity Institutional Conduct of Fire Trainer (I-COFT). The I-COFT test included offensive and defensive engagements fired in normal and degraded operational modes. The primary analysis evaluated I-COFT speed and accuracy as a function of S^3 spatial/psychomotor scores. Additional analyses compared the S^3 test scores of soldiers currently selected for EIA to those not selected and examined how S^3-based selections would differ from current procedures.

Findings:

The S^3 spatial/psychomotor tests were a strong predictor of simulated tank gunnery performance, yielding a correlation of .54 with I-COFT speed/accuracy. The 2-1/2-month interval between the predictor and criterion tests suggests that the relationship should remain stable over time. Furthermore, the strength of the relationship shrank only slightly when the EIA soldiers were given considerable additional training. Soldiers currently selected for EIA scored higher on all of the S^3 predictor tests and on the I-COFT criterion tests than soldiers not selected. Only a moderate overlap was found, however, between the current selection procedures and S^3-based selections. The results indicate that including the S^3 tests in the EIA selection process would result in EIA graduates with stronger gunnery skills.

Utilization of Findings:

The results are being used by the TRADOC Deputy Chief of Staff for Training (DCST), U.S. Army Training and Doctrine Command, and the Commanding General, U.S. Army Armor Center and School, to improve the selection criteria and thereby the quality of the graduates of the EIA program and other accelerated initial-entry programs.

ASSESSING THE IMPACT OF PSYCHOMOTOR AND LEADERSHIP SELECTION TESTS ON THE EXCELLENCE IN ARMOR PROGRAM

CONTENTS

LIST OF TABLES

LIST OF FIGURES

ASSESSING THE IMPACT OF PSYCHOMOTOR AND LEADERSHIP SELECTION TESTS ON THE EXCELLENCE IN ARMOR PROGRAM

Introduction

Success on the modern battlefield requires soldiers who can maximize the performance of their weapon systems and who are also excellent leaders. To help meet these needs, the U.S. Army Armor Center (USAARMC) in 1984 initiated the Excellence in Armor (EIA) program as a complement to armor initial-entry training. The EIA program identifies early-on in One Station Unit Training (OSUT) high-quality, motivated soldiers. The selected soldiers receive accelerated training on hard-skill armor tasks, with successful performance resulting in early promotions. The goals of the EIA program include increased retention of high-quality enlisted personnel and accelerated progression of EIA graduates into tank commander (TC) assignments. For a more detailed description of the program and EIA selection procedures, refer to the USAARMC report on CMF 19 Active Component Personnel Assessment (1985).

Similarly, the Commanding General, U.S. Army Training and Doctrine Command (TRADOC) wants to ensure that the highest quality soldiers are fighting and maintaining the high-tech weapon systems in the Army inventory. Based on this desire and the success of the EIA program, he has directed the proponent schools to implement accelerated initial-entry training programs modeled after EIA. He has further urged the schools to base the programs on the selection of individuals with outstanding abilities to perform gunnery tasks. Together with the development of comprehensive device-based prescriptive training strategies, the programs are being called Skills Selection and Sustainment (S^3).

Reports from field commanders indicate the EIA program is presently successful, in that EIA graduates are superior to other OSUT graduates. As part of continuing efforts to improve the armor force, USAARMC is, however, interested in enhancing the quality of its EIA graduates through improved EIA selection. The research reported here examines a new set of predictor tests, with potential application for selection into EIA. The S^3 selection tests were developed by the U.S. Army Research Institute in an effort to assess spatial, psychomotor, and leadership abilities. Should the implementation of the S^3 selection tests prove effective, the result would be an EIA graduate population with even greater leadership and warfighting potential.

Previous research has shown the S^3 tests to be strong predictors of armor performance, including tank gunnery and perceived NCO potential. Smith and Graham (1987) found a multiple correlation of .76 between an S^3 test battery and performance on the Unit-Conduct of Fire Trainer (U-COFT). The validation was conducted with soldiers enrolled in the Armor Officer Basic Course. As for predicting leadership ability, Gast (1988) found that the EIA graduates who scored high on the test battery were likewise rated higher by both peers and supervisors on technical and leadership abilities. The S^3 test battery thereby selected the "cream of the crop" within EIA.

Purpose of Research

The purpose of the research was to assess the utility and impact of the S^3 predictors tests as additional selection criteria for the EIA program. The major questions addressed were:

1. Do S^3 tests predict simulated tank gunnery performance?

2. Do soldiers currently selected for EIA differ in S^3 predictor test scores from those not selected?

3. How closely would S^3-based selections correspond with current selections?

Test Materials

The selection battery included two paper-and-pencil tests, the orientation test and maze test, and two computerized tracking tests. In addition, the battery included the Assessment of Background and Life Experiences (ABLE) test. A tank gunnery criterion test was developed and administered using the Institutional-Conduct of Fire Trainer (I-COFT), a high-fidelity tank gunnery simulator. A description of the tests and test devices is provided below.

Orientation Test

The orientation test is a paper-and-pencil spatial abilities test designed to measure one's ability to visualize an object when it is mentally rotated. Each item presents a rotated picture within a frame, with a circle and a dot at the bottom of the frame. The soldier's task is to mentally rotate the frame so that the circle is positioned at the bottom of the picture. Because the dot within the circle also rotates, the soldier must decide how the dot would look in relation to the circle if the frame were rotated. Five responses are provided for each of the 24 items. Figure 1 shows a sample item with alternative "B" being the correct response. The test is thought to predict success in maintaining position relative to environmental landmarks including conditions of frequent direction changes (Peterson, 1987).

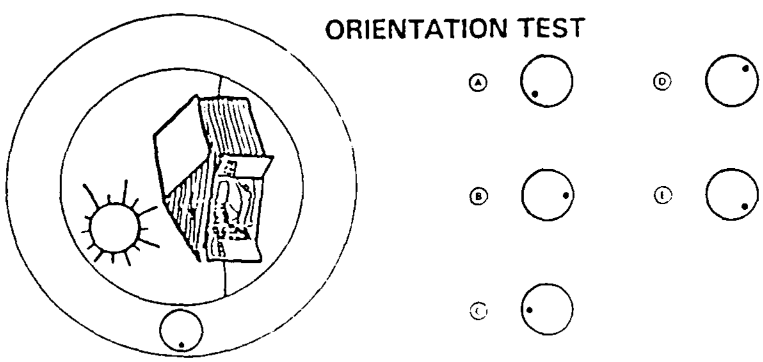


Figure 1. Sample item from the orientation test.

Maze Test

The maze test is a paper-and-pencil test designed to measure additional spatial abilities, namely spatial scanning. Spatial scanning refers to the ability to scan a complex visual field and to identify particular patterns or pathways within the field. Figure 2 shows a sample item from the maze test; alternative "B" is the correct answer. Each of the 24 items consists of a rectangular maze with four entrances and several exits. The soldier must identify the one entrance which leads to an exit. The maze test is thought to predict success in using maps in the field and in performance of electronic operations (Peterson, 1987).

MAZE TEST

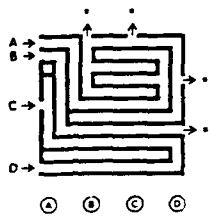
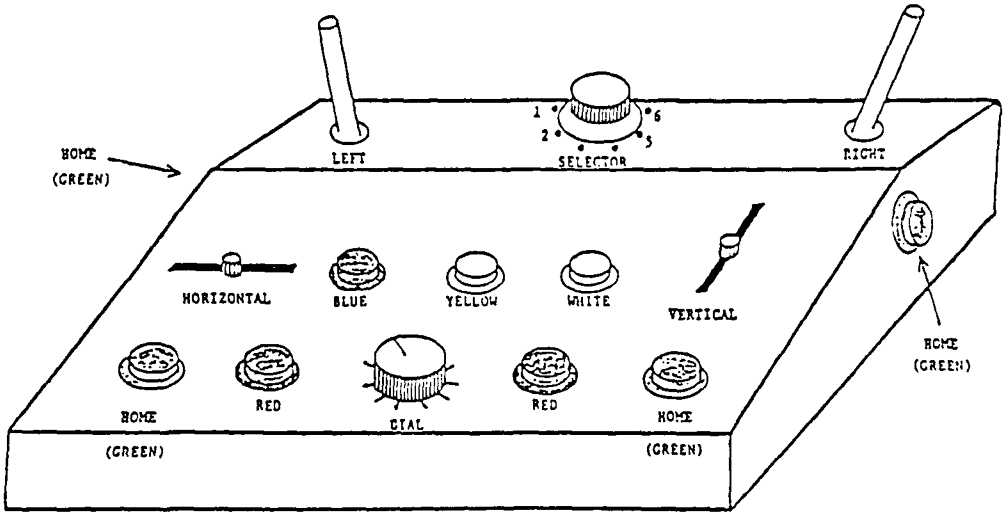


Figure 2. Sample item from the maze test.

Tracking Tests

The two tracking tests require the soldier to view a computer screen and to use the specially designed response pedestal shown in Figure 3. The two pursuit tracking tests are visually the same with the difference being in the way the soldier controls movement. In the first test the soldier uses either the right or left joystick, depending on handedness. In the second test the soldier uses the horizontal and vertical slide resistors.



Custom-designed response pedestal

Figure 3. Response pedestal used in computerized tracking tasks.

For each item as shown in Figure 4, the soldier sees a path of horizontal and vertical line segments with a target box at one end. The target box moves along the path at a constant speed. The soldiers's task is to manipulate the joystick (or horizontal and vertical slides) to keep the crosshairs in the center of the box. Across trials the speed of the target and the complexity of the path varies. The tracking tests were designed to assess fine motor control and multilimb coordination.

Figure 4. Representative screen for a tracking item.

ABLE Test

ABLE is a temperament and biodata battery designed to supplement the ASVAB. Research evidence shows that soldiers who score high on ABLE exhibit greater effort, discipline, fitness, and the likelihood of completing their first tour. The ABLE short form used in this research contained 87 multiple choice items selected from four content scales and two response validity scales. The content scales were Dominance, Work Orientation, Non-Delinquency, and Emotional Stability with the response validity scales being Non-Random Responses and Unlikely Virtues.

I-COFT

I-COFT Description. The I-COFT is a high-fidelity tank gunnery simulator which has become a central component in the suite of armor gunnery training devices. Recently the I-COFT has begun to be used as a research device for measuring tank gunnery proficiency. TC and gunner controls on the M1 I-COFT are virtually identical to those in the actual tank, making the I-COFT analogous to flight simulators used in military and commercial training. The I-COFT simulates tank optics with computer-generated imagery and can be used as either a whole-task or part-task trainer. In addition, I-COFT tests can be constructed to measure a full range of target engagement tasks, including target acquisition, laying the main gun, and issuing fire commands.

Device-mediated tests with the I-COFT offer certain advantages over other hands-on performance tests. These pluses include standardized administration and scoring, and the capability of inexpensively building longer tests with varied target conditions. Research evaluating the reliability of testing on the Unit-Conduct of Fire Trainer (U-COFT) has found test-retest reliability coefficients which exceed .80 (Graham, 1986). The I-COFT and U-COFT are essentially the same with the exception that the I-COFT includes software options which can present part-task training. Other desirable characteristics of I-COFT tests are that they can be used to separate the contributions on individual crewmen in tank gunnery engagements and can be safely administered to novice crewmen.

Test Construction. The I-COFT gunner's test developed for this research contained four exercises taken from the I-COFT's Target Engagement Practice Exercises (TEPE). The exercises were selected with the assistance of the Armor Simulator Division, Weapons Department, U.S. Army Armor School (USAARMS). The selected exercises included offensive and defensive engagements fired with daylight and thermal sights under normal and degraded operational conditions. The selection of the exercises was constrained such that the OSUT soldiers had to have been trained on the tested conditions. Table 1 shows the exercises included in the test in the order of test presentation.

Table 1

I-COFT Test Engagement Conditions

I-COFT Exercise Number	Number of Targets	Own Vehicle	Targets	Fire Control Malfunctions
31271	10	Stationary	Short Range Stationary Handles	Primary Sight, Power Control
32511	5	Moving	Long Range Moving	None
32241	10	Stationary	Long Range Stationary	Stabilization System
32321	10	Stationary	Long Range Moving	None

The one hour test required all targets to be engaged with the main gun. The test also employed the I-COFT's synthetic TC, an instructional feature whereby the software automatically acquires targets, lays the main gun, and gives fire commands. The synthetic TC, in effect, simulates a perfect TC in that it always gives correct fire commands and consistent target acquisition. All OSUT I-COFT gunnery training uses the synthetic TC, in part, because it eliminates the support requirement for a TC. For tank gunner testing purposes, the synthetic TC is ideal in that it helps ensure standardized testing.

Performance Measures. Two performance measures were obtained from each exercise: percent hits and opening time. Percent hits was simply the number of targets hit divided by the number of targets presented. Opening time measured the amount of time from when a target appeared until the first round was fired. For engagements in which no rounds were fired, an opening time of 30 seconds was assigned, the maximum I-COFT opening time possible for the selected exercises. While there are situations in battle where it is advantageous not to fire, failure to fire at I-COFT targets was, by definition, an error. Assigning the maximum opening time when the gunner did not fire gave a poor score for poor performance.

A total percent hits and mean opening time were computed by taking the mean of the means for each of the exercises. This procedure resulted in an equal weighting of the exercises, even though the offensive exercise (owntank moving) had fewer targets. A speed/accuracy composite score was also computed by subtracting the standardized opening time from the standardized percent hits. The opening times were subtracted because lower times, i.e., faster opening times, represent better performance. The speed/accuracy composites were then transformed into t-scores, giving the speed/accuracy scores a mean of 50 and a standard deviation of 10.

Method

Participants

Four hundred seventy-nine 19K (M1 tank crewman) OSUT soldiers completed both the predictor battery and the I-COFT gunnery criterion test. The soldiers were from five training companies of the 1st Armored Training Brigade (1ATB), Fort Knox, KY. Predictor scores were also obtained from an additional 1143 OSUT soldiers, including MOSs 19D (scouts) and 19E (M60 tank crewman), for a total of 1642.

Procedure

The soldiers took the predictor tests at the Fort Knox Reception Station on the third day of their initial processing into the Army. The tests were administered by a contracted testing service between February and June 1988. The order of the tests was varied to maximize the use of the computers. The orientation test and maze tests had time limits of 10 minutes and 5 1/2 minutes, respectively. The computer tracking tests and ABLE were self-paced, but usually took less than 20 minutes each. The entire testing session including instructions and breaks took around one and a half hours.

For the 19K soldiers only, I-COFT tests were administered by I-COFT Instructor/Operators (I/O) during the last (or 20th) hour of OSUT I-COFT training; this fell in the tenth week of OSUT training. Because the test was given the second hour of a two-hour block, no warm-up was deemed necessary. Prior to the initial testing session, the I/O's were explained the purpose of the project and that they should not provide assistance to the soldiers once the test exercises began. The I-COFT tests were administered between April and August 1988.

The 19K soldiers selected for the EIA program received an additional 14 hours of I-COFT training. These soldiers were readministered the I-COFT test at the end of this training. The additional training and the I-COFT retest normally occurred within a week and a half of the initial I-COFT test.

Because of data collection problems, EIA retest data were only collected from three OSUT companies. Forty-two soldiers were given the retest, of whom only 40 had taken the first test.

Performance Measures

The following variables were used in the analyses. A brief description is presented on how each was gathered, calculated, or derived.

Spatial Test Score. The score was the number of correct responses from the 48 items on the orientation and maze tsts added together and expressed as a standard score. The scaling was referenced to 3000+ trainees from combat MOSs in the Project A concurrent validation (Campbell, 1988).

Tracking Test Score. The tracking score was based on the mean log distance the cursor was from the center of the target, averaged across time and trials. Item scores for one- and two- hand tracking were summed and standardized to the norms of the Project A concurrent validation.

Spatial/Psychomotor Composite . Scores from the spatial and tracking tests were weighted equally to form a composite percentile score. The norms were based on the performance of enlisted soldiers from a number of combat MOSs, i.e., the norms do not represent tankers (CMF 19) alone.

ABLE Score. The ABLE scores, as with the spatial/psychomotor composite, represented percentiles based on norms of soldiers in combat MOSs from the concurrent validation of Project A.

GT Score. The General Technical (GT) score from the Armed Services Vocational Aptitude Battery (ASVAB) was obtained from personnel records in the training brigade headquarters. The GT scores were used as a measure of mental ability.

I-COFT Training Performance. During the 20 hours of I-COFT training in 19K OSUT, the soldiers typically received 16 Task Training Exercises. Each of these were scored Go/No Go by the I-COFT. The I-COFT Training Performance score indicated the percent GOs on these exercises. The scores ranged from about 50% to 94%.

EIA Selection Status. This measure indicated whether the soldier was selected for EIA or not.

EIA Graduation Status. This measure indicated whether the soldier graduated from EIA or not.

Percent Hits. This I-COFT measure indicated the percent of targets hit out of the 35 presented on the I-COFT test.

Opening Times. Opening Time reflected the mean amount of time the soldier required to fire the first round on each I-COFT engagement.

Speed/Accuracy Composite. Percent hits and opening times were combined into a speed/accuracy composite which was converted into a t-score. The speed/accuracy composite was used as the primary I-COFT performance measure.

Results

S^3 Prediction of I-COFT

Performance on the S^3 predictor battery was highly correlated with I-COFT gunnery performance. Table 2 shows the correlation coefficients between the S^3 spatial/psychomotor composite and I-COFT hits, opening times and the speed accuracy composite. The negative correlation of opening times with the spatial/psychomotor composite indicates that soldiers with higher spatial/psychomotor scores were faster, i.e., they had shorter opening times.

Table 2

Correlations of Spatial/Psychomotor Composite Scores with I-COFT Performance Measures

I-COFT Measure (n = 479)	r
Percent Hits	.48*
Opening Times	-.52*
Speed/Accuracy Composite	.54*

*$p < .0001$

The soldiers were then split into three equal sized groups as a function of their spatial/psychomotor composite score. Figure 5 shows I-COFT percent hits for the lower, middle, and upper spatial/psychomotor groups. An Analysis of Variance (ANOVA) found the differences in means to be significant with $F(2,476) = 51.9$, $p < .0001$.

Similarly, Table 3 shows the mean opening times and speed/accuracy composites for the three groups split on spatial/psychomotor composite. Given that the speed/accuracy composite are t-scores with a mean of 50 and standard deviation of 10, the difference between the lower and upper groups is greater than one standard deviation. Similarly, the difference between the upper and lower groups for mean percent hits and opening times were also greater than one standard deviation.

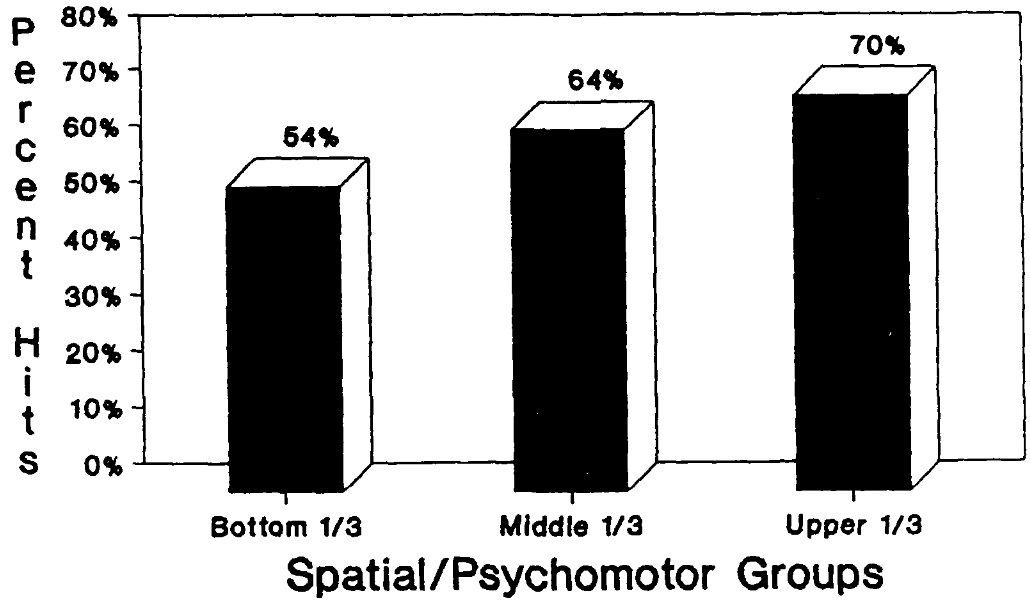


Figure 5. Percent hits for the lower, middle, and upper spatial/psychomotor composite groups.

Table 3

Opening Times and Speed/Accuracy Composites for the Lower, Middle, and Upper Spatial/Psychomotor Composite Groups

Spatial/ Psychomotor Group	Opening Time (secs) (s.d. = 2.5)	Speed/ Accuracy (s.d. = 10)
Lower 1/3	20.0	43.5
Middle 1/3	18.0	51.5
Upper 1/3	17.2	55.1
F(2,476) =	62.2*	68.2*

*p < .0001

The results show that soldiers who scored higher on the S^3 spatial/psychomotor tests were considerably more accurate and faster on the I-COFT gunnery test than those soldiers who scored lower. The 2 1/2 month time span between the predictor test battery and the I-COFT gunnery test suggests the relationship is valid over extended periods of time. The results corroborate those of Smith and Graham (1987) in showing the S^3 spatial/psychomotor tests to be valid predictors of tank gunnery performance as measured on the I-COFT.

Regression Analyses

A series of regression analyses were conducted to predict I-COFT performance from S^3 scores and other available information. For each of the regression analyses, the criterion measure was I-COFT speed/accuracy. Table 4 shows the zero-order correlations of the predictors with the I-COFT composite.

Table 4

Zero-order Correlations of Predictor Scores with I-COFT Speed/Accuracy Composite

Predictor (n = 446)	r
Spatial/psychomotor composite	.54
I-COFT training score	.48
Tracking test score	.46
Spatial test score	.40
GT score	.34
ABLE	.11

The results of the first stepwise regression analysis in which all predictors were eligible for inclusion are shown in Table 5. As is typically the case in stepwise regression analyses, variables are added only when they significantly contribute to the prediction of the criterion ($p < .05$).

These data show that I-COFT test performance is best predicted by a combination of S^3 test scores and I-COFT training performance data. Even though the two variables are moderately correlated (.53), they independently contribute to the prediction of the I-COFT test. It is somewhat surprising and encouraging that the spatial/psychomotor composite correlates more highly with the I-COFT test than does the I-COFT training performance. The S^3 tests may be the better predictor of the I-COFT test because of similar performance pressures in both the predictor and criterion testing situations.

Table 5

Stepwise Regression of I-COFT Speed/Accuracy - All Variables Included

	Predictor	Beta	Multiple R	Multiple R^2
Step 1	Spatial/psychomotor composite	.54	.54	.29
Step 2	Spatial/psychomotor composite	.39	.59	.35
	I-COFT training score	.29		

A second regression analysis examined the incremental validity of S^3 tests above GT, a readily available ASVAB score. Table 6 shows a stepwise regression after GT was forced in as the first step.

Table 6

Multiple Regression on I-COFT Speed/Accuracy - GT Entered First

	Predictor	Beta	Multiple R	Multiple R^2
Step 1	GT	.34	.34	.11
Step 2	GT	.11	.55	.30
	Spatial/psychomotor composite	.43		

This analysis shows that while mental ability, i.e., GT score, is related to the I-COFT performance, gunnery performance is more a function of spatial and psychomotor skills than of mental ability. For a more complete description of how mental ability is related to these I-COFT test scores, refer to Graham (in prep).

Table 7 shows the results of a regression analysis using predictors other than the S^3 tests, namely GT and I-COFT training scores. These data show that a combination of I-COFT training scores and GT does nearly as good of a job of predicting I-COFT performance as the S^3 tests. I-COFT training performance data is, however, only available for 19K OSUT soldiers.

Table 7

Multiple Regression on I-COFT Speed/Accuracy - S^3 Predictors Excluded

	Predictor	Beta	Multiple R	Multiple R^2
Step 1	I-COFT training score	.48	.48	.23
Step 2	I-COFT training score	.43	.52	.27
	GT	.18		

Analyses Following Additional EIA I-COFT Training

As discussed above, soldiers selected for EIA received an additional 14 hours of I-COFT training as part of the EIA accelerated training. The following analyses examined the effects of the additional training on I-COFT test performance and also on the predictive validity of the S^3 tests after the additional training. Table 8 shows I-COFT performance before and after the additional 14 hours of training for the 40 soldiers who took both tests. Not surprisingly, the additional hours of I-COFT training led to a marked improvement in gunnery performance, both in terms of speed and accuracy.

The EIA retest analyses included a highly selected group of soldiers who performed considerably better than the whole OSUT class. For example, the overall mean percent hits on the original test was .63, as compared to the EIA mean of .71. For comparison, the overall mean opening time was 18.4 seconds, and the mean speed/accuracy composite was, by definition, 50.

Figure 6 shows the mean opening times for the EIA soldiers separated into lower, middle, and upper spatial/psychomotor composite groups. The cut scores for the three groups were the same as those used in the earlier analyses. Separate ANOVAs found significant differences both before the additional hours of training, $F(2,37) = 3.53$, $p < .05$, and after $F(2,39) = 3.23$, $p < .05$. For the before training ANOVA, the n's were 9, 14, and 17.

Table 8

I-COFT Performance Measures Before and After Additional 14 Hours of Training

I-COFT Measure (n = 40)	Before	After	t(39)=
Percent Hits	.71	.84	5.37*
Opening Times (secs)	17.2	14.4	9.02*
Speed/Accuracy Composite	55.7	65.8	7.72*

*p < .0001

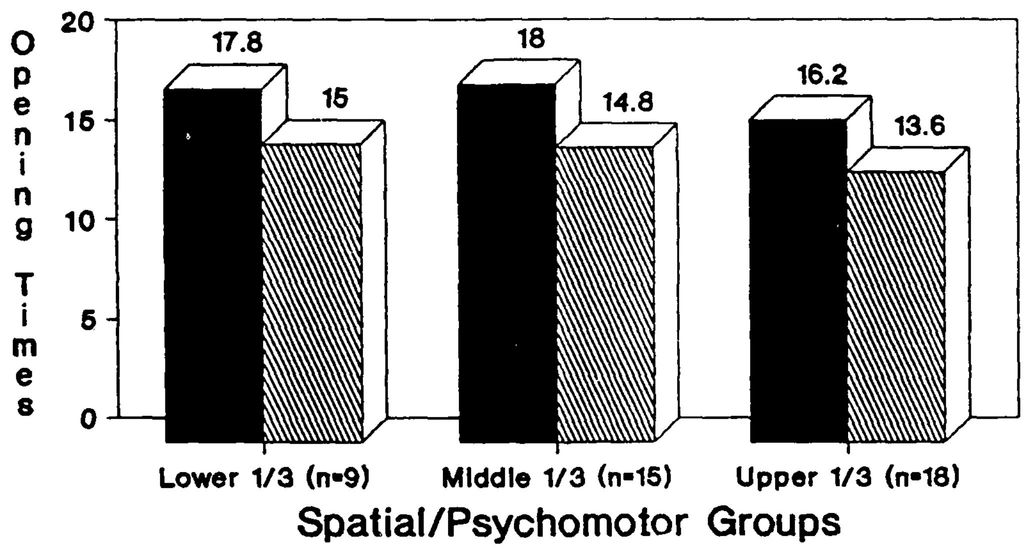


Figure 6. EIA opening times before and after the additional training.

These data show significant differences in I-COFT speed for the lower, middle, and upper spatial/psychomotor composite groups both before and after additional training. Significant differences were not, however, found for percent hits after the additional training, which was likely due to a ceiling effect. The point here is that the S^3 tests are predictive of I-COFT performance at two different levels of training. A similar finding is that the tracking test correlated with I-COFT speed/accuracy .37 before the training and .35 after the additional training. These correlations are lower than those found for the entire OSUT sample because of restricted range, i.e., the EIA soldiers were generally from the top of the distribution.

The differences shown in figure 6 are perhaps best interpreted in terms of effect size, as urged by proponents of meta-analysis, e.g., Glass (1977). Effect size reflects the magnitude of differences between groups in terms of standard deviation units. Consider then the differences relative to the 2.5 second I-COFT opening time standard deviation for the OSUT sample. The 14 hours of additional training lead to an improvement of over one standard deviation. The difference between the lower and upper S^3 groups remained about .5 standard deviations both before and after training. The latter figure is probably underestimated in that the standard deviation for opening times on the retest was 1.7 seconds. Using 1.7 as the base of comparison means, the effect size between the upper and lower groups after training was .82. An effect size of 1.0 is generally considered a large effect (Cohen, 1977).

S^3 Test Scores of EIA and Normal Track Soldiers

The current EIA selection process selects approximately 11% of OSUT soldiers for the EIA program, primarily based on training performance and supervisory evaluations. If the skills evaluated by the S^3 tests are important to the EIA program, S^3 test differences should currently exist between those soldiers selected and those not selected for EIA. Table 9 shows the mean S^3 test scores for soldiers selected and not selected. These data include scores from all three armor MOSs.

Table 9

Mean S^3 Test and GT Scores for Soldiers Selected and Not Selected for EIA

Test Scores	Selected (n=182)	Not Selected (n=1459)	t(1639)=
Spatial test	34.4	30.5	5.34*
Tracking test	56.8	53.4	5.11*
Spatial/psychomotor composite	72.1	59.1	6.29*
ABLE	68.0	54.2	5.86*
GT	109.2	103.9	5.10*

*$p < .0001$

These data show that those soldiers currently selected for EIA score higher on the S^3 tests and GT than those not selected. That the S^3 dimensions are important to EIA is further supported by a discriminant analysis which derived a discriminant function between soldiers selected and not selected for EIA. The discriminant analysis was conducted on the 19K soldiers so as to include I-COFT training data. Table 10 shows the correlation of the discriminating variables with the single canonical discriminant function. The canonical correlation was .24.

Table 10

Correlations of Test Scores with Canonical Discriminant Function

Test Score (n = 445)	r
Spatial test	.77
GT	.75
Spatial/psychomotor composite	.71
ABLE	.58
Tracking test	.44
I-COFT training score	.44

These data further show that the soldiers selected for EIA differ from those not selected on the S^3 test dimensions as well as GT. The canonical correlation indicates, however, that only 6% of the variance is accounted for by these variables. The low correlation could be due to several factors. EIA selection could be based on some set of dimensions other than psychomotor, leadership, and mental ability. Or, the intent of the selection process could be to select on these dimensions, but not be very efficient. It is likely a combination of the two. Including S^3 test information into the selection procedures would increase the efficiency of the process for selecting on these dimensions. Furthermore, explicitly using I-COFT training performance data would help select soldiers with better gunnery aptitudes. Notice in Table 10 that I-COFT training performance was least correlated with the EIA selection discriminant function.

Comparison of EIA Graduates and Non-graduates

Approximately 20% of the soldiers selected for the EIA program fail to complete the accelerated program. If the S^3 tests could additionally predict those soldiers who are likely to attrit from the program, the S^3 test utility would be greatly enhanced. Table 11 compares the S^3 and GT scores of soldiers selected for EIA who graduate to those selected who do not graduate.

Table 11

S^3 and GT Scores of Soldiers Selected for EIA Who Graduate and Who Do Not Graduate

Test Scores	Selected and Not Graduated (n=53)	Selected and Graduated (n=129)	t(180)=
Spatial test	34.9	34.2	-.57
Tracking test	56.7	56.9	.20
Spatial/psychomotor composite	72.9	72.0	-.29
ABLE	67.3	68.3	.25
GT	107.7	110.0	1.19

None of the differences are significant, which suggests that success for those selected into the EIA program is a function of factors other than psychomotor, leadership, or mental ability. Discussions with 1ATB personnel have indicated that many of the soldiers who fail to graduate from the EIA program do so because they can not meet the program's rigorous physical training (PT) standards. The soldiers who fail to graduate from EIA do, however, graduate from the OSUT program.

S^3 Overlap with Current EIA Selection

As shown earlier, soldiers currently selected for the EIA program score higher on the S^3 tests than those soldiers not selected. It may be that the 11% of the soldiers who are selected for EIA are also the top scorers on the S^3 tests. Table 12 shows the percentage of soldiers currently selected for EIA that would be included in the sample of soldiers selected based on various S^3 cuts. The S^3 percentile cuts used an equal weighting of ABLE and the spatial/psychomotor composite. The table shows, for example, if an S^3 cut score was selected to include the upper 30% of OSUT soldiers based on the S^3 test, 48% of the current EIA soldiers would be above that cut.

These results indicate a moderate overlap in the results of the current selection process and the S^3 tests. As shown in the discriminant analysis, the current EIA selection procedure is not maximizing the selection of soldiers on the basis of psychomotor and leadership abilities, at least as measured by the S^3 tests. Ongoing research at the ARI Fort Knox Field Unit is monitoring the EIA selection process with the goal being to determine those characteristics that are being used for selection.

Table 12

Percent of Current EIA Above and Below Various S^3 Cuts

S3 Cuts	Percent of Current EIA Above Cut	Percent of Current EIA Below Cut
Upper 20%	34%	66%
30%	48%	52%
40%	61%	39%
50%	74%	26%
70%	89%	11%
90%	96%	4%

A final analysis examined the results on I-COFT performance after combining the current selection procedures with S^3 cut scores. Table 13 shows the I-COFT speed/accuracy composite scores using current selection procedures, using a 30% S^3 cut score, and the cross between the two procedures.

Table 13

I-COFT Speed/Accuracy Scores Using Current and S^3 Selection Procedures

		Current EIA Selection Procedures	
		Not Selected	Selected
S^3 30% Cut	Not Selected	47.8	53.9
	Selected	53.8	55.5

These results show that the soldiers who were selected for EIA and who also were in the upper 30% on the S^3 tests performed best on the I-COFT test. These data replicate the findings of Gast (1988) in showing that the current EIA soldiers who score high on the S^3 tests are the "cream of the crop."

Discussion

The results clearly demonstrate that the S^3 spatial and psychomotor tests are valid predictors of tank gunnery performance as measured on the I-COFT. Not only were the correlations relatively high, but the 2 1/2 month interval between the predictor and criterion tests suggests the relationship should remain stable over an extended period of time. Furthermore, the strength of the relationship shrunk only slightly when the EIA soldiers were given a considerable amount of additional training. Taken together the data show the S^3 tests to be valid over time and varying levels of gunnery proficiency.

The comparison of soldiers selected for EIA to those not selected found the EIA soldiers to have better spatial, psychomotor, and leadership skills than those not selected. The EIA soldiers also had higher GT scores and performed better on the I-COFT criterion test. The analyses indicated, however, that including the S^3 test scores in the EIA selection process would result in EIA soldiers with stronger gunnery skills. The analyses also showed that I-COFT training performance data were not effectively used in the selection process. Modifications to the OSUT training schedule might have to be made in order to use the I-COFT training performance information.

The goal of the EIA program is to train leaders, in addition to strong gunnery skills. To help meet this goal, the S^3 test included ABLE which previously has been shown to predict leader potential. It was thought that ABLE might predict attrition form the EIA program, but this result was not found. Other than the attrition analyses, the research design did not test the validity of ABLE as a predictor of soft, leadership-type, skills.

The current EIA selection procedure relies heavily on supervisory evaluations which are believed to be good measures of soldier motivation and leader potential. Subjective appraisals are a necessary part of the EIA selection process, but the analyses suggest there is room for improvement. Less than five percent of the variance discriminating EIA soldier selection was accounted for by the S^3 tests, GT scores, and I-COFT training performance data. Given that the tests measure psychomotor, spatial, leadership, and mental abilities, plus hands-on I-COFT training performance, one would expect a greater difference between EIA and normal track soldiers in these important areas.

Reports from the field indicate EIA graduates are superior to other OSUT soldiers. Likewise, Mendel and Erffmeyer (1988) have shown that EIA soldiers perform at or above normal track soldiers in all areas of responsibility. The S^3 research reported here was conducted as part of an effort to improve what is unquestionably an already successful program. The critical question concerning the utility of the S^3 tests as an EIA selection tool remains unanswered. Would the overall quality of EIA graduates be higher if certain soldiers selected for the accelerated training program, i.e., those who scored low on the S^3 tests, were replaced by soldiers who scored high. The data suggest that the overall quality of the EIA graduates would increase if the S^3 tests were included in the EIA selection process. The result would be EIA soldiers with stronger leadership and warfighting abilities.

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