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This technical report describes test instruments, including two aircrew psychomotor tests, the Automated Pilot Aptitude Measurement System, and several written tests, as predictors for success in Undergraduate Pilot Training. The report recommends implementation of a pilot selection system which includes psychomotor tests, the Automated Pilot Aptitude Measurement System, and several written tests as an effective screen for entry into undergraduate pilot training. Validities are reported for individual instruments as well as for combinations of those instruments. The importance of obtaining cost effective self-contained equipment is indicated, and recommendations for future research are given.

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PREFACE

This work was performed under Project 7719, Air Force Personnel System Development on Selection, Assignment, Evaluation, Quality Control, Retention, Promotion, and Utilization; Task 771912, Selection and Classification Instruments for Officer Personnel Programs, and responds to Request for Personnel Research No. 72-18, titled Improved Screening for Undergraduate Pilot Training, issued by Air Training Command.

The data reported herein were collected under the direction or by the efforts of many individuals other than the authors; prominent among these individuals are Dr. George Long, Captain Nicholas Varney, Dr. Lonnie Valentine, Jr., Sgt Vincent Maurelli, and Sgt Louis Kaluza, to whom the authors express their appreciation.

The authors are especially indebted to the late Dr. Robert E. Miller, who was responsible for the development of the Reference Battery.

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PILOT SELECTION SYSTEM DEVELOPMENT

I. INTRODUCTION

Over the past 8 years, the Personnel Research Division of the Air Force Human Resources Laboratory (AFHRL) has performed a series of studies aimed at improvement of procedures for selection of Undergraduate Pilot Training (UPT) students. As a result of these sequential efforts, instruments have been developed which are valid for the selection of personnel for UPT; however, because of the extended fashion under which they were developed, the interrelationships among them had not been fully determined. Furthermore, the validity of these instruments, both individually and in combination, while partially established in previous studies, required further investigation.

This study addresses the issues of the joint contributions of the various selection instruments to the prediction of pilot training success. In particular, the instruments considered in this study include the aircrew psychomotor tests developed by Sanders, Valentine, and McGrevy (1971), paper-and-pencil tests which impacted revisions to the Pilot Composite (PC) of the Air Force Officer Qualifying Test (AFOQT), and the Automated Pilot Aptitude Measurement System (APAMS) developed by Long and Varney (1975).

II. SELECTION INSTRUMENTS

Paper-and-Pencil Measures

A reference battery consisting of 21 tests was assembled to measure a variety of cognitive abilities, many of which were not included in the PC of the AFOQT. Some tests from the reference battery showed point-biserial correlations with a UPT Pass/Fail criterion ranging from .13 to .19 (Miller, Note 1) and have been selected for inclusion in the latest revision (Form N) of the AFOQT. Table 1 shows the tests used in Form M and Form N of the AFOQT Pilot Composite. The scales in Form N that were taken from the Reference Battery are indicated with an asterisk. Descriptions of the tests in the Reference Battery may be found in Appendix A.

Table 1. **Pilot Composite Subscales**

Form M	Form N
Mechanical Information	* Verbal Analogies
Mechanical Principles	* Table Reading
Pilot Biographical Inventory	* Electrical Maze
	* Block Counting
Aviation Information	* Scale Reading
Visualization of Maneuvers	* Tools
	Mechanical Comprehension
Instrument Comprehension	Instrument Comprehension
Stick and Rudder Orientation	Pilot Biographical and Attitude Scale

Additionally, Guinn, Vitola, and Leisey (1976) have investigated the use of scales developed from the Strong Vocational Interest Blank (SVIB) and the Officer Background and Attitude Survey (OBAS) as pilot selection instruments and have reported significant correlations between scales from these two instruments

and UPT criteria. Based upon the work by Guinn, Vitola, and Leisey, three scales (A, B, and C) were developed with items similar in content to those in the SVIB. Those three scales and the OBAS Total Elimination (TE) and Flying Deficiency (FD) scales were used in this study.

Aircrew Psychomotor Tests

Two psychomotor coordination tests have been developed for selection of aircrew personnel: Two-Hand Coordination and Complex Coordination. The first of these tests—Two Hand Coordination—is a continuous tracking task in which the subject is required to track a target moving about in a circle with an X-shaped cursor. The movement of the cursor is controlled by two joysticks. One joystick controls the right-left (X_1-axis) movement of the cursor, while the other joystick controls the up-down (Y_1-axis) movement.

The second test—Complex Coordination—is a compensatory tracking test in which the subject is required to keep a cursor as close as possible to the intersection of a vertical and horizontal row of dots, while at the same time keeping a short bar of light as close as possible to the vertical row of dots. The movement of the cursor in the right-left (X_2) axis and up-down (Y_2) axis is controlled by a large, floor-mounted joystick, while the movement of the short bar of light in the right-left (Z_2) axis is controlled by a rudder bar. The development of these tests has been described by Sanders, Valentine, and McGrevy (1971).

For both tests, scores are obtained by summing the absolute displacements from the cursor to the target point and, for the second test, from the bar of light to the vertical row of dots, for each 1-minute period of the tests. Each test has a 3-minute practice period, followed by 5 minutes during which performance is scored, thus producing five scores for each of the control axes (X_1,Y_1,X_2, Y_2, Z_2).

McGrevy and Valentine (1974) reported correlations of .16 to .42 between the UPT Pass/Fail criterion and the scores from the 4th and 5th minutes of the Complex Coordination Test. Correlations of these scores with the Flying Training Deficiency (FTD)/Other Disposition (which includes all subjects who either passed UPT or were eliminated for other than FTD) criterion ranged from .08 to .29. An unpublished study by AFHRL staff personnel has replicated these findings (McGrevy, Note 2), and those results are summarized in Table A21.

Automated Pilot Aptitude Measurement System (APAMS)

The APAMS uses two Singer-Link General Aviation Trainers interfaced to a Varian 620 minicomputer. Subjects receive a 5-hour syllabus of instruction and testing over a variety of flight maneuvers. During each testing period, flight parameters (i.e., altitude, heading, roll rate, etc.) are monitored and recorded, and from these parameters the deviations from the command (ideal) condition are calculated. The complete 5-hour syllabus produces 190 of these command deviation scores on each subject.

In their report on the development of the system, Long and Varney (1975) reported multiple correlations ranging from .25 to .50 between various UPT criteria and factor scores obtained from the APAMS data. In this study, both factor scores and simplified APAMS parameter scores were used.

III. SAMPLE

The data reported and analyzed here were principally collected under the project Ground-Based Screening—a joint effort of the Air Training Command Flying Training Candidate Selection Division and the Air Force Human Resources Laboratory. However, some of that reported data were gathered in earlier, independent studies. Under the project Ground-Based Screening, more than 1,800 officers and officer trainees were tested, using various combinations of the selection instruments listed in Section II of this report.

The data collection effort extended over several years, beginning in 1973 with criterion collection and continuing into 1977. Since not all tests were administered to each subject, the samples of subjects tested on one instrument may overlap only partially, or not at all, with the samples tested on another instrument or set of instruments. This has complicated the data analysis procedures and has limited the number of comparisons which may be made among these instruments.

Furthermore, the numbers, characteristics, and sources of personnel entering UPT during this extended period underwent considerable fluctuation. The initial phases (1973–1974) of the data collection effort, during which most of the data on paper-and-pencil tests were collected, were characterized by a high volume of personnel entering UPT, the majority of whom were products of the Officer Training School (OTS). During this phase, also, compulsory military service was in effect.

Later in the data collection phase (1975–1976), however, the flow of personnel into UPT, especially those coming from OTS, had greatly decreased. The principal sources of input at that time were Air Force Academy graduates, Reserve Officer Training Corps honor graduates, and commissioned officers from the Air National Guard and Regular Air Force. During this time frame, both the Vietnam conflict and compulsory military service were terminated. The effects of these changes were to increase the homogeneity of abilities within the applicant pool and to increase the overall ability level because of the increased selectivity made possible with a much smaller group of trainees.

During the course of data collection, the procedures employed in UPT were modified and the pass/fail ratio changed to reflect fewer failures. This pass/fail ratio, commonly termed the p/q split, is reported later in several tables showing validity data.

This ratio is important when evaluating the correlations obtained from the analysis because the p/q split sets a limit on the magnitude of the point-biserial correlation that may be obtained. Only with a p/q split of 50/50 (that is, 50% pass and 50% fail) is a correlation of 1.0 possible. As the p/q split deviates from 50/50, the maximum correlation that may be computed decreases, so that with a 90/10 split (90% pass/10% fail) the maximum point-biserial correlation that may be obtained is approximately 0.55 (Nunnally, 1967, p. 133).

All of these circumstances doubtlessly acted to attenuate the validities obtained in this study, although their exact impact may not be determined.

IV. DATA ANALYSIS

Means, standard deviations, and correlations with two UPT criteria–Pass/Fail (for any cause) and Pass/Fail (for FTD)–for each of the instruments for which data were available are given in Tables 2 through 7. In those cases where the test instrument produces an error score (in which good performance is indicated by a low score), the signs of the correlation coefficients have been reflected so as to produce positive coefficients.

The means and standard deviations of the 190 variables obtained from the APAMS are not reported, as those variables are not themselves used in further analyses. Because of the large number of variables obtained from the APAMS, some form of data reduction was considered desirable. The Long and Varney (1975) analyses used a factor analytic procedure to reduce the number of variables, and this approach has also been followed in this analysis.

A principal components factor analysis, followed by Varimax rotation, was performed on the 190 APAMS variables. This procedure resulted in the identification of the six factors given in Table 3. However, because of the instability of the factor coefficients obtained from an analysis of 190 variables with only 140 subjects (the usual rule of thumb is to have 10 times as many subjects as variables), another, simpler data reduction procedure was also carried out.

Table 2. **Means, Standard Deviations, and Correlations[a] with UPT Criteria for Psychomotor Coordination Tests**

Variable	Mean	SD	r(Pass/Fail) (N = 137) p/q = 72/28	r(Pass/FTD) (N = 114) p/q = 85/15
Two-Hand Coordination				
X-Axis, Min. 4	910.15	321.55	.15	.07
X-Axis, Min. 5	948.31	328.35	.21*	.21*
Y-Axis, Min. 4	868.00	309.21	.13	.14
Y-Axis, Min. 5	875.22	318.70	.13	.19*
X-Axis, Min. 4 + 5	1,858.47	601.19	.19*	.15
Y-Axis, Min. 4 + 5	1,743.22	577.41	.14	.18*
Complex Coordination				
X-Axis, Min. 4	450.71	453.50	.18*	.14
X-Axis, Min. 5	412.78	459.48	.16	.15
Y-Axis, Min. 4	438.46	532.43	.18*	.12
Y-Axis, Min. 5	396.53	502.58	.19*	.14
Z-Axis, Min. 4	2,672.95	5,647.72	.17*	.07
Z-Axis, Min. 5	3,063.58	6,231.91	.22**	.17
X-Axis, Min. 4 + 5	863.49	885.20	.17*	.15
Y-Axis, Min. 4 + 5	834.99	998.29	.19*	.14
Z-Axis, Min. 4 + 5	5,736.53	11,353.33	.21*	.13

[a]Signs have been reflected.

*p < .05.

**p < .01.

Table 3. **Means, Standard Deviations, and Correlations[a] with UPT Criteria for APAMS Factor Scores and Parameter Scores**

Variable	Mean	SD	r(Pass/Fail) (N = 140) p/q = 71/29	r(Pass/FTD) (N = 117) p/q = 85/15
Factor I – Heading	0	1.0	.18*	.03
Factor II – Bank	0	1.0	.27*	.37**
Factor III – Attitude	0	1.0	.00	.08
Factor IV – Side Slip	0	1.0	.15	.09
Factor V – Bank II	0	1.0	.20*	.13
Factor VI – Position	0	1.0	–.04	–.08
Average Pitch Angle	2.09	.52	.26**	.18
Average Bank Angle	5.01	2.04	.28**	.33**
Average Side Slip	1.61	.37	.19*	.11
Average Heading	9.10	9.94	.27**	.19*
Average Altitude	96.36	68.20	.20*	.22*

[a]Signs have been reflected.

*p < .05.

**p < .01.

Table 4. **Means, Standard Deviations, and Correlations with UPT Criteria for SVIB Blank Scales**

Variable	Mean	SD	r(Pass/Fail) (N = 265) p/q = 72/28	r(Pass/FTD) (N = 227) p/q = 84/16
SVIB Key A	40.06	6.38	.13*	.06
SVIB Key B	33.41	7.56	.16*	.09
SVIB Key C	38.32	31.99	−.06	−.01

*p < .05.

Table 5. **Means, Standard Deviations, and Correlations with UPT Criteria for OBAS**

Variable	Mean	SD	r(Pass/Fail) (N = 257) p/q = 72/28	r(Pass/FTD) (N = 220) p/q = 85/15
Total Elimination Scale	1.76	1.31	.15*	.05
Flying Deficiency Scale	.69	1.17	.13*	.03

*p < .05.

Table 6. **Means, Standard Deviations, and Correlations with UPT Criteria for Reference Battery Scales**
(N = 245, Tested During FY 74)[a]

Variables	Mean	SD	r(Pass/Fail) p/q = 85/15	r(Other[b]/FTD) p/q = 92/8
Scale Reading	16.18	4.50	.19**	.16*
Letter Sets	18.75	4.31	.10	.15*
Tool Functions	6.58	1.85	.04	.08
Electrical Information	6.78	1.80	.02	.10
Mechanical Principles	7.87	1.90	.10	.12
Word Knowledge	8.24	1.70	.03	.15*
Word Grouping	8.09	1.48	−.01	−.04
Verbal Analogies	8.32	1.52	.13*	.19**
Block Counting	34.71	8.60	.18**	.15*
Point Distance	25.13	9.78	.04	.06
Electrical Maze	7.44	4.17	.13*	.14*
Pattern Detail	7.65	3.27	.07	.14*
Rotated Blocks	6.11	2.12	.08	.10
Tools	7.11	1.91	.04	.02
Figure Analogies	7.19	1.99	.01	.04
Hidden Figures	4.63	3.00	.05	.03
Answer Sheet Marking	98.78	15.74	.05	.09
Table Reading	22.59	6.57	.17**	.08
Large Tapping	69.07	15.00	.05	.10
Trace Tapping	101.25	24.86	.05	.03
Discrimination-Reaction	87.60	17.50	.06	.02

[a]Data taken from Miller (Note 1).

[b]"Other" Category includes graduates and all personnel eliminated for other than Flying Training Deficiency.

*p < .05.

**p < .01.

Table 7. **Means, Standard Deviations and Correlations with UPT Criteria for AFOQT (Form M) Raw Scores**
(N = 245, Tested During FY 74)[a]

Variable	Mean	SD	r(Pass/Fail)	r(Other/FTD)[b]
Pilot Composite	103.09	17.16	.15*	.10
Navigator Composite	123.71	25.68	.11	.05
Officer Quality	119.64	16.45	.08	.00
Verbal	40.12	7.32	.10	−.04
Quantitative	37.76	9.05	.13*	.05

[a]Data taken from Miller (Note 1).

[b]"Other" category includes graduates and all personnel eliminated for other than Flying Training Deficiency.

*p < .05.

The additional variables reported in Table 3 are the simple averages of all APAMS variables that were in the same metric—that is, the mean absolute deviation from the command Pitch Angle, Bank Angle, etc.

Where overlapping samples permitted, the intercorrelations of the test variables from each instrument were computed. These correlations are presented in Tables Al through A20, in Appendix A.

Tables 8 and 9 present the multiple correlations obtained between the set of scores obtained from each instrument and the Pass/Fail and Pass/FTD criteria, respectively. In these and subsequent tables, the seven predictors reported for the Reference Battery are those scales which appear in the PC of Form N of the AFOQT; however, these are not all of the scales which constitute the PC. Therefore, these correlations should not be taken as representing the total validity of the PC for Form N of the AFOQT.

Table 8. **Regression Problems for Single Predictor Sets with Pass/Fail Criterion**

Problem No.	Predictor Set	No. of Predictors	N	R
1	Psychomotor Tests	10	137	.34
2	APAMS Parameter Scores	5	140	.32*
3	APAMS Factor Scores	6	140	.41**
4	SVIB	3	265	.18*
5	OBAS	2	257	.15
6	Reference Battery[a]	7	245	.25*
7	Reference Battery[b]	7	131	.17
8	AFOQT (Pilot and Navigator Composites)[a] Form M	2	245	.15

[a]Data taken from Miller (Note 1).

[b]Data from subjects who also were tested on APAMS.

*p < .05.

**p < .01.

Table 9. **Regression Problems for Single Predictor Sets with Pass/FTD Criterion**

Problem No.	Predictor Set	No. of Predictors	N	R
1	Psychomotor Tests	10	114	.33
2	APAMS Parameter Scores	5	117	.37**
3	APAMS Factor Scores	6	117	.42**
4	SVIB	3	227	.14
5	OBAS	2	220	.05
6	Reference Battery[a]	7	245	.26*
7	Reference Battery[b]	7	109	.35*
8	AFOQT (Pilot and Navigator Composites)[a] Form M	2	245	.10

[a]Data taken from Miller (Note 1). Criterion in this case is FTD/Other Disposition.

[b]Data from subjects who also were tested on APAMS.

*$p < .05$.

**$p < .01$.

For those cases where there were sufficient subjects to permit analysis, the multiple correlations between combinations of instruments and the two training criteria were computed. These multiple correlations are given in Table 10.

The data reported for the APAMS thus far have been based upon the subjects tested by Long and Varney. An additional sample of subjects was also tested—referred to hereafter as the cross-validation sample. Using the weights generated by the factor analysis of the Long and Varney data, six factor scores were generated for each subject in the cross-validation sample, corresponding to the factors reported in Table 3. The correlations between these six factor scores and the two training criteria are given in Table 11. Table 12 gives the correlations between these training criteria and the five APAMS Parameter scores for the cross-validation sample.

In order to assess the shrinkage in the multiple correlations, the regression weights obtained from problems 2 and 3 given in Table 8 and problems 2 and 3 given in Table 9 were applied to the APAMS factor scores and parameter scores to generate predicted UPT criteria values. The correlations between these predicted values and the two UPT criteria are given in Table 13.

As an alternative to the use of regression weights to form an overall APAMS score, a unit weighting scheme was evaluated in which each of the five APAMS parameter scores (in standard score form) was assigned a weight of 1.0, and the overall APAMS score was formed by taking the simple arithmetic sum of the scores. The correlations between this APAMS composite score and the two training criteria for both the Long and Varney sample and the cross-validation sample are given in Table 14.

Tables 15 and 16 report multiple correlations with UPT Pass/Fail and Pass/FTD for selected sets of predictors.

An operation similar to that used with the APAMS data was performed on the psychomotor coordination test scores. From Tables 15 and 16, it may be seen that Test 1 (Two-Hand Coordination) makes little contribution to Test 2 (Complex Coordination) for the prediction of either criterion. Furthermore, if the sum of the scores from minutes 4 and 5 for each control axis ($X_4 + X_5$; $Y_4 + Y_5$; $Z_4 + Z_5$) are used, there is again little decrease in validity.

Finally, by taking the arithmetic sum of the scores from each axis (in standard score form), a single Psychomotor Composite score may be found. This composite score, which is simply the arithmetic sum of all the scores from the 4th and 5th minutes of Test 2, retains much of the validity of the other scoring procedures while being much more convenient to apply.

Table 10. **Regression Problems for Combinations of Predictor Sets**

Problem No.	Predictor Sets	No. of Predictors	Pass/Fail Criterion		Pass/FTD Criterion	
			N	R	N	R
1	Psychomotor Tests and APAMS Factor Scores	11	137	.51**	114	.51**
2	Psychomotor Tests and SVIB	8	218	.29*	186	.25
3	Psychomotor Tests and OBAS	7	210	.30**	179	.24
4	Psychomotor Tests and Reference Battery	12	130	.37	108	.41
5	Psychomotor Tests and AFOQT – Form M	7	106	.30	87	.17
6	APAMS Parameter Scores and Psychomotor Tests	10	139	.41*	114	.40*
7	APAMS Parameter Scores and SVIB	8	123	.35*	101	.41*
8	APAMS Parameter Scores and OBAS	7	116	.24	95	.37*
9	APAMS Parameter Scores and Reference Battery	12	131	.38*	109	.52**
10	APAMS Parameter Scores and AFOQT – Form M	7	106	.35	88	.40*
11	APAMS Factor Scores and SVIB	9	123	.44**	101	.51**
12	APAMS Factor Scores and OBAS	8	116	.39*	95	.42*
13	APAMS Factor Scores and Reference Battery	13	131	.51**	109	.56**
14	APAMS Factor Scores and AFOQT – Form M	8	107	.48**	88	.52**
15	SVIB and OBAS	5	256	.23*	219	.16
16	SVIB and Reference Battery	10	258	.22	220	.26
17	SVIB and AFOQT – Form M	5	215	.17	181	.14
18	OBAS and Reference Battery	9	250	.15	213	.17
19	OBAS and AFOQT – Form M	4	207	.16	174	.07
20	Reference Battery and AFOQT – Form M	9	106	.27*	245	.27*
21	Reference Battery and AFOQT – Form M[a]	9	245	.27*	245	.27*

[a]Data taken from Miller (Note 1).

* $p < .05$.

** $p < .01$.

Table 11. **Validity of APAMS Factor Scores for Cross-Validation Sample[a]**

Factor	Pass/Fail (N = 116)		Pass/FTD (N = 99)	
I – Heading	.18*	(.18*)	.18	(.03)
II – Bank	.15	(.27*)	.15	(.37**)
III – Altitude	.20*	(.00)	.25*	(.08)
IV – Side Slip	.16	(.15)	.14	(.09)
V – Bank II	.06	(.20*)	.16	(.13)
VI – Position	.20*	(–.04)	.21*	(–.08)

[a]Validities from validation sample (Table 3) are shown in parentheses for comparison.

*$p < .05$.

**$p < .01$.

Table 12. **Validity of APAMS Parameter Scores for Cross-Validation Sample[a]**

	Pass/Fail (N = 116)		Pass/FTD (N = 99)	
Pitch	.28**	(.26**)	.37**	(.18)
Bank	.27**	(.28**)	.25*	(.33**)
Side Slip	.15	(.19*)	.19	(.11)
Heading	.09	(.27*)	.14	(.19*)
Altitude	.18*	(.20*)	.22*	(.22*)

[a]Validities from validation sample (Table 3) are shown in parentheses for comparison.

*$p < .05$.

**$p < .01$.

Table 13. **Application of Regression Coefficients to Cross-Validation Sample**

Problem No.	Predictor Set	No. of Variables	Criterion	N	R
1	APAMS Parameter Score	5	Pass/Fail	116	–.09
2	APAMS Parameter Score	5	Pass/FTD	99	.23
3	APAMS Factor Score	6	Pass/Fail	116	–.08
4	APAMS Factor Score	6	Pass/FTD	99	.27

Table 14. **Validities of APAMS Composite Score Generated from Parameter Scores (in Standard Score Form)**

Criterion	N	R
	Sample 1	
Pass/Fail	140	.30*
Pass/FTD	117	.26*
	Sample 2	
Pass/Fail	116	.25*
Pass/FTD	99	.31*

*p < .01.

Table 15. **Regression Problems for Various Predictor Systems for UPT Pass/Fail Criterion**

Problem No.	Predictors	No. of Predictors	N	R
1	Reference Battery	7	131	.17
2	Psychomotor Tests (Tests 1 & 2, Mins. 4 & 5)	10	137	.34
3	Psychomotor Test 2 (Min. 4, Min. 5)	6	137	.31*
4	Psychomotor Test 2 (Min. 4 + Min. 5)	3	137	.30**
5	Psychomotor Composite Score	1	137	.29**
6	APAMS Composite	1	140	.30**
7	APAMS Composite, Psychomotor Composite	2	137	.36**
8	APAMS Composite, SVIB Scale B	2	123	.30**
9	APAMS Composite, OBAS T.E. Scale	2	116	.24*
10	APAMS Composite, Reference Battery	8	112	.30
11	Psychomotor Composite, Reference Battery	8	130	.34*
12	Psychomotor Composite, Reference Battery, APAMS Composite	9	130	.42**
13	Psychomotor Composite, Reference Battery, APAMS Composite, OBAS T.E. Scale	10	113	.38
14	Psychomotor Composite, Reference Battery, APAMS Composite, SVIB Scale B	10	120	.41*
15	Psychomotor Composite, Reference Battery, APAMS Composite, OBAS T.E. Scale, SVIB Scale B	11	112	.40*
16	Psychomotor Composite, Reference Battery, OBAS T.E. Scale	9	113	.33
17	Psychomotor Composite, Reference Battery, SVIB Scale B	9	120	.34
18	Psychomotor Composite, Reference Battery, OBAS T.E. Scale, SVIB Scale B	10	112	.36
19	Reference Battery, OBAS T.E. Scale SVIB Scale B	9	249	.23

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

Table 16. **Regression Problems for Various Predictor Systems for UPT Pass/FTD Criterion**

Problem No.	Predictors	No. of Predictors	N	R
1	Reference Battery	7	109	.35*
2	Psychomotor Tests (Test 1 & 2, Min. 4 & 5)	10	114	.33
3	Psychomotor Test 2 (Min. 4, Min. 5)	6	114	.27
4	Psychomotor Test 2 (Min. 4 + Min. 5)	3	114	.21
5	Psychomotor Composite Score	1	114	.20*
6	APAMS Composite	1	117	.26**
7	APAMS Composite, Psychomotor Composite	2	114	.29**
8	APAMS Composite, SVIB Scale B	2	101	.29*
9	APAMS Composite, OBAS T.E. Scale	2	95	.21
10	APAMS Composite, Reference Battery	8	91	.46**
11	Psychomotor Composite, Reference Battery	8	108	.39*
12	Psychomotor Composite, Reference Battery, APAMS Composite	9	108	.46*
13	Psychomotor Composite, Reference Battery, APAMS Composite, OBAS T.E. Scale	10	92	.47*
14	Psychomotor Composite, Reference Battery, APAMS Composite, SVIB Scale B	10	98	.48**
15	Psychomotor Composite, Reference Battery, APAMS Composite, OBAS T.E. Scale, SVIB Scale B	11	91	.48*
16	Psychomotor Composite, Reference Battery, OBAS T.E. Scale	9	92	.43*
17	Psychomotor Composite, Reference Battery, SVIB Scale B	9	98	.41*
18	Psychomotor Composite, Reference Battery, OBAS T.E. Scale, SVIB Scale B	10	91	.43*
19	Reference Battery, OBAS T.E. Scale SVIB Scale B	9	212	.21

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

V. RESULTS AND DISCUSSION

Before reporting the results obtained in this study, it would be well to review briefly the difficulties which beset the analyses and the limitations which these conditions have placed on the interpretation and generalizability of the results.

As noted earlier, the characteristics of the sample and, to some degree, the nature of the training environment changed during the course of data collection. Furthermore, those tests which required the use of an apparatus–specifically the Psychomotor Coordination tests and the APAMS–were influenced by variations in the apparatus itself.

In the case of the Psychomotor test device, abnormalities in the test results which appeared during the data analysis made it apparent that a random malfunction in the equipment had occurred approximately halfway through the study. This malfunction increased scores obtained by subjects and thus partially invalidated the scores obtained by the later subjects. Since it appeared that the onset of this malfunction coincided roughly with the end of testing for the first APAMS sample, the scores for these subjects were used in determining validity coefficients for the Psychomotor tests.

The intercorrelations of the Psychomotor tests with the other variables are based on the entire sample of subjects because, otherwise, there would be too few cross-matching cases. The correlations are attenuated because of the increased random variability of the Psychomotor variables, however, and can only be regarded as approximations to the true values.

For the APAMS, equipment malfunctions and difficulties encountered in reading data from the magnetic tape files produced by the system resulted in the loss of some data, especially for the second, cross-validation sample. Here, in those cases where data were missing, the means of the particular variables were inserted. This has the effect of reducing the variance of those variables and attenuating their correlations with the criteria. Validities reported for the cross-validation sample are therefore somewhat biased to be lower than the true validities which might have been obtained under better conditions.

Validities obtained for the Psychomotor Coordination tests were slightly lower than those obtained in previous studies, probably due, at least in part, to the equipment difficulties noted earlier. Nevertheless, several significant correlations were obtained between these variables and the two criteria. The multiple correlations of the Psychomotor tests, using all variables, and the two criteria were moderate, but were not statistically significant because of the number of predictor variables relative to the number of subjects. However, by going through the reduction or simplification procedures described earlier, Psychomotor Composite scores were obtained that did correlate significantly with the criteria: .29 for Pass/Fail and .20 for the Pass/FTD.

Both the Factor scores and the Parameter scores obtained from the APAMS demonstrated significant correlations with the two criteria in both validation and cross-validation samples. In the validation sample, multiple correlations of .41 and .42 were obtained between the Factor scores and the Pass/Fail and Pass/FTD criteria, respectively. For the Parameter scores, multiple correlations of .32 and .37 were obtained.

Application of the four regression equations obtained from the validation sample to the cross-validation sample resulted in a reduction of the multiple correlations. For the Factor scores, these shrunken multiple correlations were −.08 and .27 for the Pass/Fail and Pass/FTD criteria, respectively; while for the Parameter scores, the multiple correlations were reduced to −.09 and .25 for the respective criteria. This shrinkage was considered excessive; therefore, the procedure described earlier for the generation of a single APAMS Composite score was accomplished. This Composite score correlated .30 and .26 with the Pass/Fail and Pass/FTD criteria, respectively, in the validation sample and .25 and .31 with the two criteria in the cross-validation sample. All of these correlations were statistically significant and did not experience the shrinkage between samples to which the scores generated using regression weights were subjected.

Low but statistically significant correlations were obtained between scales from the SVIB and the Pass/Fail criterion. However, correlations of these scales with the Pass/FTD criterion were not significant.

For the seven scales from the Reference Battery that were included in Form N of the AFOQT, correlations with the Pass/Fail criterion ranged from .10 to .19, while correlations of these scales with a criterion of FTD/Other Disposition ranged from .08 to .19. The multiple correlations of these seven scales with the Pass/Fail and FTD/Other criteria were .25 and .26, respectively.

The Pilot Composite of the previous version of the AFOQT (Form M) correlated .15 and .10 with the Pass/Fail and FTD/Other criteria, respectively. These are of approximately the same order but slightly lower than uncorrected correlations reported by Miller (1966, 1969, 1972, 1974) which ranged from .20 to .36. However, these correlations seriously underestimate the true correlations in the population because all

subjects had already been selected for training, based upon their scores on the AFOQT, Pilot Composite. Miller (1969) estimates the unrestricted correlation with Pass/Fail to be .40.

While no direct validation of the Pilot Composite for Form N of the AFOQT was possible in this study, it is possible to arrive at an estimate of that value. Using the data from Miller (Note 1), the composite correlation of seven of the scales from Form N with the Pass/Fail criterion is .25. The scales which appear in the AFOQT are approximately twice as long as those in the Reference Battery: correcting for this increased test length yields a correlation of .26. Including the contribution of the Pilot Biographical and Attitude Scale raises the correlation to .30, and the inclusion of the estimated independent contribution of the Instrument Comprehension scale yields a correlation of .33. The same operations performed on the data available from subjects who were tested on the APAMS yields a correlation of .26. Similar operations performed on the correlations with FTD/Other Disposition obtained from the Miller data and Pass/FTD from the APAMS study yield estimated correlations of .30 and .39, respectively.

From these data, it would seem that the validity for the PC of Form N should fall in the range of .30 to .40. An overall estimated validity of .35 seems appropriate and should be fairly indicative of the degree of relationships between the PC and UPT performance within the restricted sample for which data were available. The unrestricted correlation, therefore, would be on the order of .40 or greater.

In Table 10, multiple correlations are reported for the two training criteria using each pair of predictor sets for which sufficient data were available. Correlations here range from .15 to .51 for the Pass/Fail criterion and from .07 to .56 for the Pass/FTD criterion. In these analyses, all variables or scales from each test (except the Reference Battery) were included. This gives fairly high multiple correlations for many of the combinations, but it also results in nonsignificant correlations in several cases because of the ratio of predictors to subjects.

In Tables 15 and 16, the number of variables taken from each test have been reduced with a view to obtaining the most parsimonious set of predictors. For the Pass/Fail criterion, the best combination of predictors consists of the Psychomotor Composite score, APAMS Composite score, and the seven scales from the Reference Battery. This combination yields a multiple correlation of .42 which is statistically significant.

Addition of both the best scales from the OBAS and SVIB do not improve upon this combination and, in fact, result in a small decrease (−.02) in the multiple correlation. This phenomenon, which may also be noted in other instances, is a function of the poor match among subjects on the different tests, so that of the 130 subjects who had scores available on the Psychomotor tests, APAMS, and Reference Battery, only 112 also had scores available on the OBAS and SVIB.

Because of this artifact and the possible influence it might have on the assumptions underlying the F test, statistical comparisons of these prediction models were considered inappropriate.

However, it is possible to make some comparisons based on the observed results. The Psychomotor Composite, by itself, correlates .29 with the Pass/Fail criterion. Adding the APAMS Composite results in a multiple correlation of .36 and, as noted above, adding the seven scales from the Reference Battery brings the multiple correlation up to .42.

Alternatively, a system consisting of just the Psychomotor Composite and the Reference Battery gives a multiple correlation of .34. Adding the SVIB and OBAS increases the multiple correlation to .36.

For the Pass/FTD criterion, similar results are obtained. The combination of Psychomotor Composite scores, APAMS Composite scores, and Reference Battery scales give a multiple correlation of .46. In this case, adding the SVIB and OBAS increases the multiple correlation to .48.

The system consisting of just the Psychomotor Composite and Reference Battery gives a multiple correlation of .39 and, adding the SVIB and OBAS increases the multiple correlation to .43.

VI. CONCLUSIONS AND RECOMMENDATIONS

The results of this study support earlier studies regarding the validity of Psychomotor Coordination tests and the APAMS for the prediction of UPT criteria. Furthermore, these results have demonstrated how the scoring procedures used for these tests may be simplified with little reduction in validity.

It is evident that either or both of these tests can add to the validity of a selection system based on paper-and-pencil tests. Whether it is economically feasible to do so is another question which is beyond the scope of this study.

It is recommended that a pilot selection system utilizing paper-and-pencil measures (AFOQT), psychomotor tests (in particular the Complex Coordination Test), and the APAMS be adopted. Paper-and-pencil measures provide an effective, valid means of initial screening; the psychomotor tests contribute unique variance, supplemented by the APAMS apparatus.

Future selection research will be directed at developing low cost devices to measure the abilities which contribute to the validity of the APAMS. Additionally, new areas of testing, such as biophysiological measures, information processing skills, and measures tapping higher-level integrative abilities should be addressed.

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APPENDIX A: REFERENCE BATTERY SCALES

Scale Reading — Is a test of the subject's ability to read scales, dials, and meters. There are a variety of scales with various points indicated on them by numbered arrows. The subject is to estimate the numerical value indicated by each arrow. There are four sample items and 24 scored items, divided into two separately timed sections.

Letter Sets — Has items which contain five groups of letters with four letters in each group. Four of the groups of letters are alike in some way. The subject is to find the rule that makes the four groups alike. The fifth group is different from the others and will not fit the rule. He indicates his knowledge of the rule by selecting the group that does not fit. The subject is given two sample items and 30 scored items, divided into two separately timed sections.

Tool Functions — Contains questions about the use of tools. In each of the ten items, a tool is depicted and five statements are given concerning the use or type of the tool. The subject must select the statement that best fits the illustration.

Electrical Information — Is a test of the subject's knowledge of electricity and electrical devices. It contains ten items which cover a variety of electrical principles and applications.

Mechanical Principles — Contains 10 items covering mechanical principles and devices, such as gears and pulleys.

Word Knowledge — Is a test of how well the subject understands words. Each of the 10 items consists of an underlined word followed by five choices. The subject is to decide which one of the five choices most nearly matches the meaning of the underlined word.

Word Grouping — Consists of 10 items each containing five words. The subject's task is to select the word that does not belong with the others.

Verbal Analogies — Is a test of the subject's ability to determine the relationships between words. In these 10 items the subject is given one relationship and part of another. The subject's task is to select from among the five choices the one that best completes a relationship similar to the first one (i.e., **Hoof** is to **cow** as **paw** is to **X**).

Block Counting — Is a test of the subject's ability to "see into" a three-dimensional pile of blocks and determine how many pieces are touched by certain numbered blocks. There are two sample items followed by 80 scored items divided into two separately timed sections.

Point Distance — Is a test of the subject's ability to compare small distances quickly. Each problem has a central point surrounded by some lines and circles, among which there is a dot marked "a" and a dot marked "b." The subject is to decide which one of the two lettered dots is nearer the centeral point. There are two sample items. The test is divided into two separately timed sections with 30 items in each section.

Electrical Maze — Is a test of the subject's ability to choose a correct path from among five choices. For each item there is a diagram which consists of a large circle at the top of the picture and five lettered boxes at the bottom. In each box there is a dot marked "S" and a dot marked "F." Lines lead from these points to the other boxes and to the circle, with dots indicating connections between lines. The subject must choose the box which has a connection from the "S" through the circle and back to the "F" in the same box. Only one of the five boxes in each item will meet this condition. There are three examples and 16 scored items.

Pattern Detail	Is a test of the subject's ability to remember patterns which have been made by arranging straight lines in several ways. The subject is given 5 minutes to study a page containing 15 of these patterns. The subject is then given 15 items in which he must identify which one of five alternatives had been presented on the study page.
Rotated Blocks	Presents the subject with a reference block and requires that he decide which one of five other blocks is the same as the reference block, were it rotated in 3-dimensional space. There are four sample problems and 10 scored items.
Tools	Is a test about tools and how they are used. Each of the 10 items has a picture of a tool and four other objects. The subject must decide which one of the four objects goes with the pictured tool.
Figure Analogies	Is a test of how well the subject can discover logical relationships. The subject is given two figures which have a certain relationship to each other. Then a third figure is given which has that same relationship to one of five alternative figures. The subject's task is to select that figure from the alternatives which bears the same relationship to the single figure that the two original figures bear to each other. There are two sample items and 10 scored items.
Hidden Figures	Is a test of the subject's ability to see a simple figure in a complex drawing. At the top of each page are five figures, and below these are some numbered drawings. The subject is to determine which lettered figure is contained in each of the numbered drawings.
Answer Sheet Marking	Is a test of how quickly and how accurately the subject can mark answers. The questions in this test appear as pairs of numbers. Each pair stands for one space on the answer sheet. The first number is the number of the question and the second is the number of the space to blacken for that question. There are two separately timed sections in this test, each containing 75 items.
Table Reading	Is a test of the subject's ability to read tables quickly and accurately. The items in this test consist of pairs of numbers which correspond to numbers appearing on the abcissa and ordinate of a large table. The subject's task is to find the entry in the table at the intersection of the row and column designated by the pair of numbers. There are five practice problems and 43 scored items in this test.
Large Tapping	Requires that the subject place three pencil dots inside a large number of circles arrayed regularly across the page. The score is the number of circles in which the subject places the three dots during the time limit.
Trace Tapping II	Consists of small numbered circles connected by an irregular line. The subject is to place one dot in each circle as quickly as he can, starting with the circle numbered one and proceeding along the irregular line. The score is the number of circles in which the subject places a dot.
Discrimination-Reaction	Is a test of speed of reaction to a signal. The signal is an arrangement of a black circle and a white circle within a box. The subject's task is to place a check mark on one of four lines to indicate the relationship of the white circle to the black circle. There are eight practice problems and 100 scored items on the test.

Table A1. **Intercorrelation of Psychomotor Coordination Scores and APAMS Parameter Scores**
(N = 137)

	1	2	3	4	5	6	7	8	9	10
1. Test 1 – X-Axis										
2. Test 1 – Y-Axis	.83									
3. Test 2 – X-Axis	.37	.31								
4. Test 2 – Y-Axis	.29	.20	.54							
5. Test 2 – Z-Axis	.08	.07	.00	–.04						
6. Average Pitch Angle	.30	.28	.29	.21	.11					
7. Average Bank Angle	.24	.24	.25	.16	.03	.78				
8. Average Side Slip	.31	.27	.37	.25	–.03	.47	.35			
9. Average Heading	.24	.30	.29	.16	.14	.65	.63	.33		
10. Average Altitude	.28	.27	.09	.04	.25	.61	.59	.31	.75	

Table A2. **Intercorrelation of Psychomotor Coordination Scores and APAMS Factor Scores**
(N = 137)

	1	2	3	4	5	6	7	8	9	10	11
1. Test 1 – X-Axis											
2. Test 1 – Y-Axis	.83										
3. Test 2 – X-Axis	.37	.31									
4. Test 2 – Y-Axis	.29	.20	.54								
5. Test 2 – Z-Axis	.08	.07	.00	–.04							
6. APAMS Factor I	.15	.22	.20	.08	–.12						
7. APAMS Factor II	.02	–.08	.07	.06	.00	–.00					
8. APAMS Factor III	.22	.23	–.08	–.03	.31	–.00	.00				
9. APAMS Factor IV	.10	.06	.16	.28	–.09	.02	.02	.01			
10. APAMS Factor V	.10	.08	.21	.08	.17	.00	–.01	.00	.00		
11. APAMS Factor VI	–.04	.01	.06	.04	.00	.00	.00	.00	.01	.00	

Table A3. **Intercorrelation of Psychomotor Coordination Scores and SVIB Keys**
(N = 229)

	1	2	3	4	5	6	7	8
1. Test 1 – X-Axis								
2. Test 1 – Y-Axis	.84							
3. Test 2 – X-Axis	.35	.30						
4. Test 2 – Y-Axis	.15	.09	.47					
5. Test 2 – Z-Axis	.17	.16	–.02	–.08				
6. SVIB Key A	.17	.18	.24	.10	.05			
7. SVIB Key B	.17	.17	.26	.12	.04	.97		
8. SVIB Key C	–.03	–.12	–.11	–.02	–.00	–.40	–.41	

Table A4. **Intercorrelation of Psychomotor Coordination Scores and OBAS Scales**
(N = 221)

	1	2	3	4	5	6	7
1. Test 1 – X-Axis							
2. Test 1 – Y-Axis	.85						
3. Test 2 – X-Axis	.37	.35					
4. Test 2 – Y-Axis	.13	.10	.45				
5. Test 2 – Z-Axis	.19	.17	–.02	–.08			
6. Total Elimination Scale	.07	.07	.14	.15	–.02		
7. Flying Deficiency Scale	.02	.02	.05	.07	–.04	.68	

Table A5. **Intercorrelation of Psychomotor Coordination Scores and Reference Battery Scales**
(N = 235)

	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	26
1. Test 1 – X-Axis																										
2. Test 1 – Y-Axis	.84																									
3. Test 2 – X-Axis	.34	.29																								
4. Test 2 – Y-Axis	.21	.15	.50																							
5. Test 2 – Z-Axis	.17	.15	–.02	–.07																						
6. Scale Reading	.07	.03	.08	.14	.00																					
7. Letter Sets	.11	.10	.05	.08	.04	.39																				
8. Tool Functions	.14	.15	.18	.19	.00	.12	.18																			
9. Electrical Information	.07	.06	.18	.08	–.11	.18	.15	.34																		
10. Mechanical Principles	.17	.15	.20	.14	.04	.22	.31	.52	.34																	
11. Word Knowledge	–.10	–.11	–.20	–.13	–.16	.20	.09	.09	.23	.06																
12. Word Grouping	.01	–.01	.02	.05	–.07	.27	.23	.06	.11	.13	.20															
13. Verbal Analogies	–.01	–.04	–.05	.06	–.09	.28	.20	.04	.15	.13	.34	.37														
14. Block Counting	.25	.24	.13	.17	.07	.20	.41	.29	.07	.39	.04	.19	.14													
15. Point Distance	.15	.07	.12	.20	.01	.16	.20	.06	–.04	.05	.00	.12	.12	.38												
16. Electrical Maze	.17	.09	.19	.22	–.07	.32	.29	.27	.25	.39	.08	.10	.03	.43	.07											
17. Pattern Detail	.17	.16	.19	.20	–.09	.35	.30	.22	.17	.26	.12	.29	.22	.35	.29	.34										
18. Rotated Blocks	.19	.16	.12	.20	.01	.29	.32	.29	.20	.35	.07	.22	.14	.49	.22	.36	.33									
19. Tools	.18	.12	.20	.13	.01	.13	.11	.46	.32	.49	.08	.06	.13	.23	–.03	.28	.16	.20								
20. Figure Analogies	.13	.08	.10	.16	–.05	.45	.41	.24	.21	.31	.14	.24	.27	.37	.17	.30	.41	.39	.26							
21. Hidden Figures	.19	.21	.09	.17	.06	.38	.31	.27	.17	.33	.11	.22	.18	.45	.22	.29	.31	.31	.33	.47						
22. Answer Sheet Marking	.23	.19	.14	.19	–.04	.09	.20	.06	.08	.00	–.01	.09	.17	.31	.34	.07	.15	.12	.09	.18	.26					
23. Table Reading	.18	.16	.15	.21	–.01	.28	.30	.04	.10	.11	.09	.14	.25	.43	.36	.17	.32	.24	.06	.24	.30	.57				
24. Large Tapping	.12	.12	.08	.11	–.07	.07	.03	.15	.13	.07	.10	.00	.08	.26	.17	.01	.05	.15	.12	.11	.08	.11	.17			
25. Trace Tapping	.13	.11	.17	.08	–.13	.05	.12	.13	.15	.10	–.05	–.04	–.01	.26	.19	.08	.03	.08	.09	.12	.20	.32	.30	.36		
26. Discrimination-Reaction	.08	.08	.13	.11	.05	.18	.07	.01	.12	.03	–.04	.13	.15	.11	.18	.07	.13	.17	–.03	.08	.09	.21	.32	.08	.13	

Table A6. **Intercorrelation of Psychomotor Coordination Scores and AFOQT Composites (Form M)**
(N = 194)

	1	2	3	4	5	6	7	8	9
1. Test 1 – X-Axis									
2. Test 1 – Y-Axis	.94								
3. Test 2 – X-Axis	.18	.15							
4. Test 2 – Y-Axis	.07	.02	.44						
5. Test 2 – Z-Axis	.11	.11	.03	–.04					
6. Pilot Composite	.06	.06	.25	.20	–.05				
7. Navigator Composite	–.05	–.06	.15	.19	–.11	.42			
8. Officer Quality	–.17	–.18	–.08	.05	–.13	.14	.53		
9. Verbal	–.16	–.18	–.20	–.03	–.09	.09	.41	.76	
10. Quantitative	–.07	–.08	.06	.07	–.09	.11	.73	.67	.48

Table A7. **Intercorrelation of APAMS Parameter Scores and SVIB Keys**
(N = 123)

	1	2	3	4	5	6	7
1. Average Pitch Angle							
2. Average Bank Angle	.76						
3. Average Side Slip	.43	.31					
4. Average Heading	.66	.64	.32				
5. Average Altitude	.60	.60	.29	.75			
6. SVIB Key A	.07	.08	.24	.16	.12		
7. SVIB Key B	.07	.08	.24	.15	.10	.97	
8. SVIB Key C	–.03	.03	–.16	.09	.05	–.38	–.37

Table A8. **Intercorrelation of APAMS Factor Scores and SVIB Keys**
(N = 123)

	1	2	3	4	5	6	7	8
1. APAMS Factor I								
2. APAMS Factor II	–.01							
3. APAMS Factor III	.01	.04						
4. APAMS Factor IV	.01	–.02	.02					
5. APAMS Factor V	.00	–.03	.02	–.04				
6. APAMS Factor VI	.00	–.01	.00	–.01	.02			
7. SVIB Key A	.05	–.06	.11	.24	.19	–.03		
8. SVIB Key B	.04	–.03	.08	.23	.19	–.01	.97	
9. SVIB Key C	.10	–.00	.03	–.03	.09	.06	–.34	–.37

Table A9. **Intercorrelation of APAMS Parameter Scores and OBAS Scales**
(N = 116)

	1	2	3	4	5	6
1. Average Pitch Angle						
2. Average Bank Angle	.75					
3. Average Side Slip	.42	.29				
4. Average Heading	.67	.64	.30			
5. Average Altitude	.61	.60	.28	.75		
6. Total Elimination Scale	.25	.23	.15	.33	.30	
7. Flying Deficiency Scale	.29	.31	.09	.39	.37	.67

Table A10. **Intercorrelation of APAMS Factor Scores and OBAS Scales**
(N = 166)

	1	2	3	4	5	6	7
1. APAMS Factor I							
2. APAMS Factor II	.05						
3. APAMS Factor III	.01	−.11					
4. APAMS Factor IV	.00	.07	.03				
5. APAMS Factor V	−.02	.14	.05	−.07			
6. APAMS Factor VI	.00	−.06	−.02	.00	.01		
7. Total Elimination Scale	−.02	−.01	.03	−.02	−.03	.00	
8. Flying Deficiency Scale	.21	−.09	.22	.08	.15	.00	−.19

Table A11. **Intercorrelation of APAMS Parameter Scores and Reference Battery Scales**
(N = 131)

	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. Average Pitch Angle																									
2. Average Bank Angle	.77																								
3. Average Side Slip	.46	.33																							
4. Average Heading	.66	.65	.33																						
5. Average Altitude	.62	.61	.31	.75																					
6. Scale Reading	.19	.19	.10	.28	.19																				
7. Letter Sets	.04	−.05	.16	.17	.03	.38																			
8. Tool Functions	.19	.14	.35	.23	.19	.15	.18																		
9. Electrical Information	.13	.14	.27	.22	.16	.26	.33	.28																	
10. Mechanical Principles	.21	.17	.24	.34	.25	.30	.34	.45	.40																
11. Word Knowledge	−.14	−.20	−.07	−.14	−.09	.08	.16	.04	.21	.00															
12. Word Grouping	.08	−.02	.10	.06	.00	.26	.32	.09	.28	.24	.24														
13. Verbal Analogies	−.02	−.08	.08	.05	.01	.31	.21	.04	.25	.23	.33	.42													
14. Block Counting	.20	.11	.24	.14	.15	.26	.37	.29	.18	.41	−.02	.19	.13												
15. Point Distance	.15	.08	.17	.10	.04	.12	.26	.17	.07	.12	.00	.15	.10	.44											
16. Electrical Maze	.15	.08	.27	.08	.08	.26	.24	.29	.19	.36	−.02	.15	−.01	.42	.00										
17. Pattern Detail	.19	.17	.22	.25	.21	.22	.22	.20	.24	.18	.04	.35	.25	.36	.30	.26									
18. Rotated Blocks	.31	.23	.18	.30	.23	.27	.36	.29	.22	.38	.02	.30	.27	.48	.26	.28	.31								
19. Tools	.13	.02	.32	.08	.09	.18	.05	.35	.30	.42	.01	.07	.13	.17	−.02	.28	.09	.14							
20. Figure Analogies	.13	.03	.21	.21	.13	.42	.48	.32	.33	.36	.14	.19	.28	.37	.19	.32	.34	.45	.28						
21. Hidden Figures	.11	.06	.18	.17	.19	.38	.34	.24	.19	.31	.07	.19	.19	.50	.32	.25	.24	.31	.31	.46					
22. Answer Sheet Marking	.18	.09	.15	.15	.04	.14	.24	.06	.09	.00	.01	.10	.09	.35	.33	.05	.12	.17	.07	.19	.33				
23. Table Reading	.24	.25	.15	.25	.13	.20	.33	.06	.16	.12	.05	.14	.20	.37	.41	−.01	.26	.23	.28	.20	.30	.66			
24. Large Tapping	.15	.10	.11	.03	.07	.16	.04	.15	.11	.01	.11	−.07	−.03	.22	.16	.06	.12	.12	.06	.11	.10	.08	.14		
25. Trace Tapping	.10	.08	.17	.02	.04	.13	.11	.13	.16	.10	−.04	−.01	.01	.32	.26	.07	.04	.09	.10	.11	.35	.39	.35	.33	
26. Discrimination-Reaction	.10	.22	.04	.08	.02	.21	.11	.02	.07	.00	−.09	.15	.14	.15	.21	−.09	.09	.18	−.08	.06	.09	.23	.35	.10	.14

Table A12. **Intercorrelation of APAMS Factor Scores and Reference Battery Scales**
(N = 131)

	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	26
1. APAMS Factor I																										
2. APAMS Factor II	−.01																									
3. APAMS Factor III	.00	.04																								
4. APAMS Factor IV	.02	−.01	.02																							
5. APAMS Factor V	.01	−.03	.01	−.03																						
6. APAMS Factor VI	−.01	.00	.00	.01	.01																					
7. Scale Reading	.23	.06	.08	.03	.07	.12																				
8. Letter Sets	.21	.02	.09	.24	.06	.10	.38																			
9. Tool Functions	.10	.04	.10	.19	.06	.03	.15	.18																		
10. Electrical Information	.15	−.01	.04	.19	.07	.10	.26	.33	.28																	
11. Mechanical Principles	.25	.00	.16	.20	.06	.10	.30	.34	.45	.40																
12. Word Knowledge	−.06	−.07	−.07	−.06	−.14	−.11	−.08	.16	.04	.21	.00															
13. Word Grouping	.15	−.06	−.06	.12	−.14	.17	.26	.32	.09	.28	.24	.24														
14. Verbal Analogies	.08	−.14	−.03	.01	−.11	.09	.31	.21	.04	.25	.23	.33	.42													
15. Block Counting	.09	.00	.10	.10	.10	.08	.26	.37	.29	.18	.41	−.03	.19	.13												
16. Point Distance	.06	.01	.03	.16	−.03	.07	.12	.26	.17	.17	.12	.00	.15	.10	.44											
17. Electrical Maze	.09	.04	−.01	.07	.08	−.01	.26	.24	.29	.19	.36	.02	.15	−.01	.42	.00										
18. Pattern Detail	.25	.06	.07	.04	−.05	.14	.22	.22	.20	.24	.18	.04	.35	.25	.36	.30	.26									
19. Rotated Blocks	.13	.01	.17	.12	.14	.15	.27	.36	.29	.22	.38	.02	.30	.27	.48	.26	.28	.31								
20. Tools	−.03	−.07	.05	.17	.00	.17	.18	.05	.35	.30	.42	.01	.07	.13	.17	−.02	.28	.09	.14							
21. Figure Analogies	.14	−.07	.08	.09	.08	.10	.42	.48	.32	.33	.36	.14	.19	.28	.37	.19	.32	.34	.45	.28						
22. Hidden Figures	.15	−.15	.16	.21	.03	−.04	.38	.34	.24	.19	.31	.07	.19	.19	.30	.32	.25	.24	.31	.31	.46					
23. Answer Sheet Marking	.17	.00	−.01	.13	.04	.10	.14	.24	.06	.09	.00	.01	.10	.09	.35	.33	.05	.12	.17	.07	.19	.33				
24. Table Reading	.21	.11	.01	.13	.06	.17	.20	.33	.06	.16	.12	.05	.14	.20	.37	.41	−.01	.26	.23	.08	.20	.30	.66			
25. Large Tapping	−.01	.06	.06	−.03	.11	.14	.16	.04	.15	.11	.01	.11	−.07	−.03	.22	.16	.06	.12	.12	.06	.11	.10	.08	.14		
26. Trace Tapping	.05	.04	.02	.09	.00	−.09	.13	.11	.13	.16	.10	−.04	−.01	.01	.32	.26	.07	.04	.09	.10	.11	.35	.39	.35	.33	
27. Discrimination-Reaction	−.03	.02	−.02	.08	.25	.03	.21	.11	.02	.07	.00	−.09	.15	.14	.15	.21	−.10	.09	.18	−.08	.06	.09	.23	.34	.10	.14

Table A13. **Intercorrelation of APAMS Parameter Scores and AFOQT (Form M) Composites**
(N = 106)

	1	2	3	4	5	6	7	8	9
1. Average Pitch Angle									
2. Average Bank Angle	.80								
3. Average Side Slip	.47	.35							
4. Average Heading	.68	.66	.35						
5. Average Altitude	.67	.64	.33	.81					
6. Pilot Composite	.44	.42	.29	.43	.37				
7. Navigator Composite	.17	.16	.23	.11	.06	.51			
8. Officer Quality	−.14	−.17	−.07	−.13	−.14	.12	.51		
9. Verbal	−.21	−.27	−.12	−.20	−.18	.04	.33	.75	
10. Quantitative	−.01	−.01	.10	.00	−.08	.13	.75	.69	.47

Table A14. **Intercorrelation of APAMS Factor Scores and AFOQT (Form M) Composites**
(N = 106)

	1	2	3	4	5	6	7	8	9	10
1. APAMS Factor I										
2. APAMS Factor II	−.02									
3. APAMS Factor III	.04	.01								
4. APAMS Factor IV	.03	.00	.05							
5. APAMS Factor V	.01	−.12	.00	.02						
6. APAMS Factor VI	−.02	.02	.02	.00	.01					
7. Pilot Composite	.32	−.01	.01	.25	.12	.22				
8. Navigator Composite	.10	.03	−.15	.11	.10	.13	.44			
9. Officer Quality	−.03	.00	−.15	.03	−.22	.17	.12	.51		
10. Verbal	−.04	−.11	-.14	−.05	−.34	.11	.04	.33	.75	
11. Quantitative	.03	.04	−.19	.08	.03	.09	.13	.75	.69	.47

Table A15. **Intercorrelation of SVIB and OBAS Scales**
(N = 378)

	1	2	3	4
1. SVIB Key A				
2. SVIB Key B	.97			
3. SVIB Key C	−.43	−.43		
4. Total Elimination Scale	.22	.20	−.01	
5. Flying Deficiency Scale	.05	.05	.12	.63

Table A16. **Intercorrelation of SVIB and Reference Battery Scales**
(N = 348)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
1. Key A																							
2. Key B	.97																						
3. Key C	−.42	−.41																					
4. Scale Reading	.07	.07	−.12																				
5. Letter Sets	.10	.11	−.02	.41																			
6. Tool Functions	.19	.20	.00	.18	.15																		
7. Electrical Information	.15	.15	−.11	.22	.22	.33																	
8. Mechanical Principles	.23	.24	−.11	.26	.31	.51	.38																
9. Word Knowledge	−.03	−.03	−.09	.25	.18	.09	.22	.17															
10. Word Grouping	−.04	−.04	−.02	.26	.23	.13	.14	.21	.30														
11. Verbal Analogies	−.03	.00	−.05	.34	.27	.09	.24	.27	.39	.40													
12. Block Counting	.14	.15	−.05	.36	.37	.29	.18	.38	.14	.22	.24												
13. Point Distance	−.04	−.04	−.01	.18	.21	.06	.07	.12	.11	.14	.16	.33											
14. Electrical Maze	.06	.08	−.02	.32	.31	.30	.29	.39	.12	.17	.11	.45	.07										
15. Pattern Detail	.10	.12	−.01	.28	.26	.22	.17	.31	.13	.27	.23	.33	.24	.30									
16. Rotated Blocks	.07	.07	.02	.35	.35	.36	.30	.46	.12	.26	.25	.52	.21	.40	.35								
17. Tools	.15	.17	−.03	.09	.11	.52	.32	.50	.07	.14	.15	.21	.00	.32	.17	.30							
18. Figure Analogies	.13	.14	−.09	.41	.42	.27	.27	.35	.19	.27	.28	.39	.23	.36	.37	.46	.29						
19. Hidden Figures	.16	.17	−.08	.37	.32	.27	.22	.36	.17	.26	.22	.45	.27	.31	.36	.39	.30	.49					
20. Answer Sheet Marking	.16	.16	−.01	.18	.23	.07	.11	.06	.12	.10	.22	.41	.31	.10	.13	.12	.01	.25	.26				
21. Table Reading	.11	.11	.02	.30	.36	.07	.14	.14	.12	.14	.26	.37	.37	.17	.22	.21	−.02	.27	.28	.51			
22. Large Tapping	.06	.06	−.01	.09	.07	.14	.16	.12	.13	.04	.16	.31	.14	.08	.13	.19	.10	.09	.08	.15	.12		
23. Trace Tapping	.07	.08	.02	.05	.16	.07	.10	.11	.05	.07	.07	.25	.14	.12	.07	.08	.04	.14	.20	.31	.26	.24	
24 Discrimination-Reaction	.12	.11	−.02	.19	.12	.00	.11	.07	.01	.11	.17	.16	.19	.07	.12	.17	−.07	.12	.11	.24	.27	.14	.16

Table A17. **Intercorrelation of SVIB Keys and AFOQT (Form M) Composites**
(N = 305)

	1	2	3	4	5	6	7
1. SVIB Key A							
2. SVIB Key B	.97						
3. SVIB Key C	−.43	−.43					
4. Pilot Composite	.04	.05	−.02				
5. Navigator Composite	.11	.13	−.20	.42			
6. Officer Quality	−.03	−.01	−.11	.18	.56		
7. Verbal	−.17	−.16	−.08	.15	.42	.77	
8. Quantitative	.14	.14	−.19	.10	.73	.68	.47

Table A18. **Intercorrelation of OBAS and Reference Battery Scales**
(N = 340)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
1. Total Elimination Scale																						
2. Flying Deficiency Scale	.63																					
3. Scale Reading	.15	.02																				
4. Letter Sets	.18	.03	.41																			
5. Tool Functions	.12	.10	.17	.15																		
6. Electrical Information	.22	.09	.23	.22	.33																	
7. Mechanical Principles	.13	.09	.26	.30	.51	.39																
8. Word Knowledge	.03	.02	.26	.19	.09	.22	.17															
9. Word Grouping	.05	.03	.27	.23	.13	.14	.21	.30														
10. Verbal Analogies	.00	−.08	.34	.26	.09	.25	.28	.40	.40													
11. Block Counting	.09	−.03	.36	.36	.29	.17	.36	.14	.22	.23												
12. Point Distance	.15	.07	.18	.19	.07	.05	.10	.12	.14	.16	.33											
13. Electrical Maze	.15	.10	.32	.32	.30	.29	.38	.13	.17	.11	.45	.08										
14. Pattern Detail	.16	.05	.28	.26	.23	.18	.32	.13	.27	.22	.34	.23	.32									
15. Rotated Blocks	.19	.09	.34	.34	.36	.29	.44	.13	.26	.24	.50	.21	.40	.36								
16. Tools	.06	.08	.09	.11	.52	.32	.50	.06	.14	.16	.21	−.01	.32	.18	.30							
17. Figure Analogies	.25	.07	.39	.40	.26	.27	.34	.20	.27	.26	.39	.23	.37	.36	.47	.29						
18. Hidden Figures	.15	.06	.37	.32	.27	.22	.36	.17	.26	.22	.44	.27	.32	.37	.39	.30	.49					
19. Answer Sheet Marking	.10	.01	.17	.20	.08	.08	.03	.12	.10	.21	.40	.29	.11	.13	.11	.01	.25	.26				
20. Table Reading	.21	.07	.30	.34	.07	.13	.13	.12	.14	.25	.36	.35	.17	.22	.20	−.02	.27	.28	.50			
21. Large Tapping	−.06	−.04	.08	.06	.13	.16	.12	.13	.03	.16	.31	.15	.07	.13	.19	.11	.07	.07	.14	.11		
22. Trace Tapping	.04	−.02	.04	.14	.07	.08	.10	.05	.06	.06	.25	.12	.13	.06	.07	.04	.13	.20	.29	.25	.23	
23. Discrimination-Reaction	.04	.01	.18	.11	.00	.10	.06	.01	.11	.16	.15	.17	.08	.11	.16	−.06	.11	.10	.22	.26	.14	.15

Table A19. **Intercorrelation of OBAS Scales and AFOQT (Form M) Composites**
(N = 296)

	1	2	3	4	5	6
1. Total Elimination Scale						
2. Flying Deficiency Scale	.65					
3. Pilot Composite	.14	.19				
4. Navigator Composite	.16	−.03	.42			
5. Officer Quality	.07	−.05	.19	.55		
6. Verbal	−.01	−.02	.15	.43	.76	
7. Quantitative	.20	−.03	.11	.73	.68	.47

Table A20. **Intercorrelation of Reference Battery Scales and AFOQT (Form M) Composites**
(N = 1,047)

	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. Scale Reading																									
2. Letter Sets	.46																								
3. Tool Functions	.24	.18																							
4. Electrical Information	.25	.21	.37																						
5. Mechanical Principles	.34	.29	.52	.44																					
6. Word Knowledge	.27	.24	.17	.21	.22																				
7. Word Grouping	.28	.29	.18	.16	.26	.31																			
8. Verbal Analogies	.37	.33	.21	.24	.33	.41	.47																		
9. Block Counting	.40	.40	.28	.19	.38	.17	.23	.31																	
10. Point Distance	.23	.25	.16	.05	.20	.18	.18	.21	.39																
11. Electrical Maze	.30	.28	.34	.35	.37	.12	.16	.19	.43	.19															
12. Pattern Detail	.26	.26	.19	.15	.26	.13	.20	.23	.30	.21	.24														
13. Rotated Blocks	.40	.32	.30	.25	.41	.16	.26	.27	.45	.22	.31	.32													
14. Tools	.17	.09	.52	.36	.49	.12	.16	.19	.22	.10	.29	.13	.31												
15. Figure Analogies	.41	.42	.29	.28	.39	.27	.32	.38	.42	.27	.34	.36	.46	.23											
16. Hidden Figures	.36	.38	.27	.23	.34	.18	.27	.29	.40	.28	.29	.35	.40	.24	.50										
17. Answer Sheet Marking	.24	.28	.07	.07	.10	.10	.14	.18	.37	.22	.13	.15	.12	.00	.20	.21									
18. Table Reading	.40	.42	.14	.17	.21	.16	.20	.25	.43	.34	.22	.22	.23	.08	.31	.31	.59								
19. Large Tapping	.12	.17	.10	.09	.10	.07	.10	.15	.30	.19	.11	.11	.17	.06	.16	.21	.26	.23							
20. Trace Tapping	.14	.23	.11	.11	.16	.08	.12	.12	.27	.22	.11	.13	.16	.07	.21	.23	.32	.29	.51						
21. Discrimination-Reaction	.24	.25	.11	.10	.15	.15	.15	.19	.31	.26	.16	.16	.21	.04	.21	.20	.27	.31	.17	.16					
22. Pilot Composite	.15	.06	.24	.23	.32	.07	.08	.11	.18	.04	.28	.12	.24	.31	.15	.16	−.04	.05	.02	.02	.08				
23. Navigator Composite	.34	.25	.20	.26	.30	.13	.15	.15	.26	.13	.29	.20	.22	.17	.32	.30	.07	.18	.06	.11	.11	.53			
24. Officer Quality	.25	.22	.06	.14	.13	.20	.19	.22	.15	.09	.12	.09	.16	.03	.23	.17	.08	.13	.03	.04	.06	.29	.61		
25. Verbal	.21	.18	.09	.12	.15	.29	.30	.31	.09	.07	.08	.10	.14	.05	.24	.14	.03	.08	.03	.03	.04	.21	.45	.70	
26. Quantitative	.31	.31	.09	.26	.22	.17	.17	.17	.24	.13	.23	.16	.28	.05	.32	.28	.10	.22	.07	.10	.08	.26	.75	.69	.46

Table A21. **Means, Standard Deviations, and Correlations with UPT Criteria for Psychomotor Coordination Tests (McGrevy Study)[a]**

(N = 150)

Variable	Mean	SD	r(Pass/Fail)[b]	r(FTD/Other)[c]
		Two-Hand Coordination		
X-Axis, Min. 4	1,087.91	451.92	.19	.27
X-Axis, Min. 5	1,049.64	434.13	.20	.29
Y-Axis, Min. 4	1,094.48	420.09	.14	.27
Y-Axis, Min. 5	1,077.78	406.58	.20	.30
		Complex Coordination		
X-Axis, Min. 4	690.12	495.52	.21	.27
X-Axis, Min. 5	646.08	487.01	.20	.25
Y-Axis, Min. 4	609.99	538.00	.24	.26
Y-Axis, Min. 5	553.55	445.89	.18	.26
Z-Axis, Min. 4	887.43	1,018.01	.15	.25
Z-Axis, Min. 5	815.06	976.75	.19	.28

[a]Data taken from McGrevy (Note 2).

[b]Signs have been reflected.

[c]"Other" category includes all subjects who either graduated or were eliminated from UPT for other than FTD.

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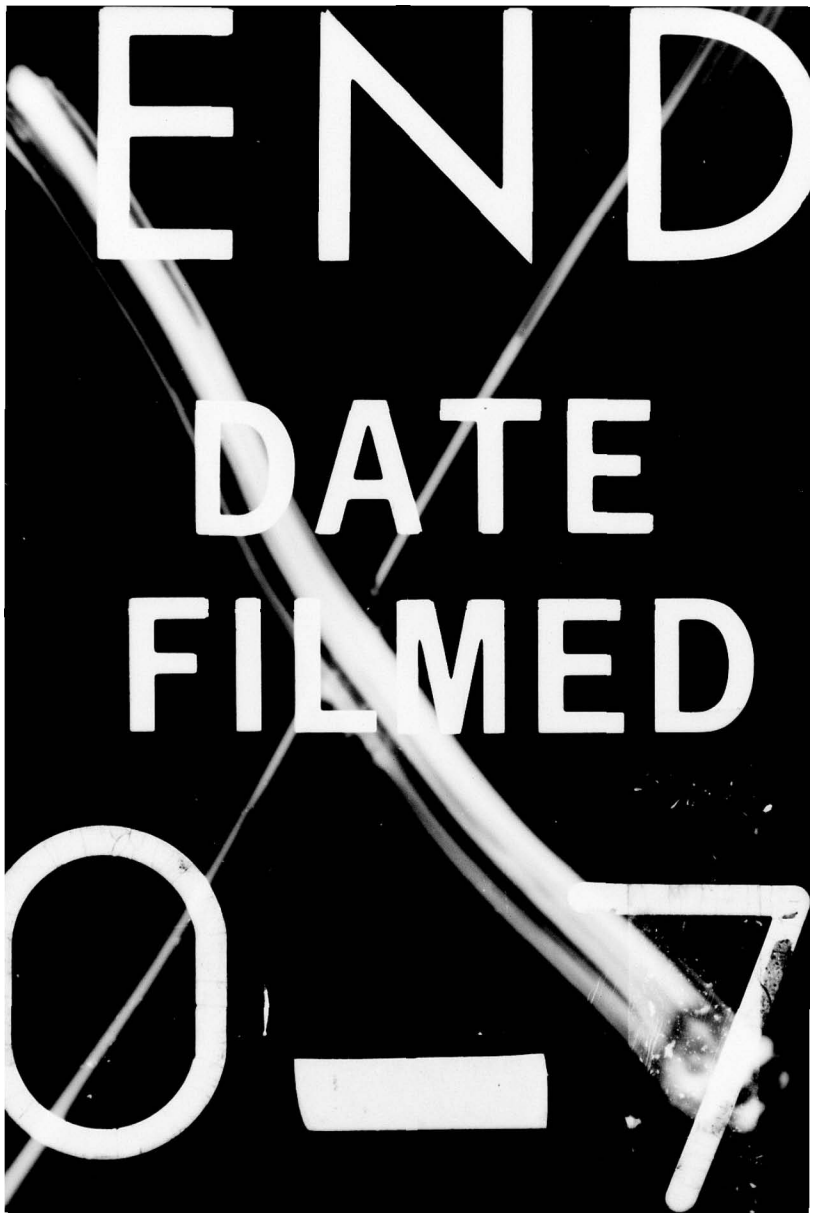
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AD-A058 418 AIR FORCE HUMAN RESOURCES LAB BROOKS AFB TEX F/G 5/1
PILOT SELECTION SYSTEM DEVELOPMENT.(U)
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SUPPLEMENTARY

INFORMATION

AIR FORCE HUMAN RESOURCES LABORATORY
Brooks Air Force Base, Texas 78235

Errata

Number	First Author	Title
AFHRL-TR-73-19 (AD-775 714)	Guinn	Effect of an All-Volunteer Force on Input into the School of Military Sciences, Officer Training Program
AFHRL-TR-76-9 (AD-A025 851)	Guinn	Background and Interest Measures as Predictors of Success in Undergraduate Pilot Training
AFHRL-TR-77-36 (AD-A042 689)	Valentine	Navigator-Observer Selection Research: Development of New Air Force Officer Qualifying Test Navigator-Technical Composite
AD-A058418 AFHRL-TR-78-33 (AD-A058 418)	Hunter	Pilot Selection System Development

Due to scoring errors which were found in the data files of the Air Force Officer Qualification Test — Forms L, M, and N, all analyses using aptitude scores derived from these test forms which are contained in the subject technical reports above are considered erroneous.

NANCY GUINN, Technical Director
Manpower and Personnel Division