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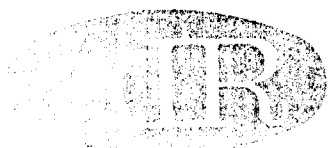
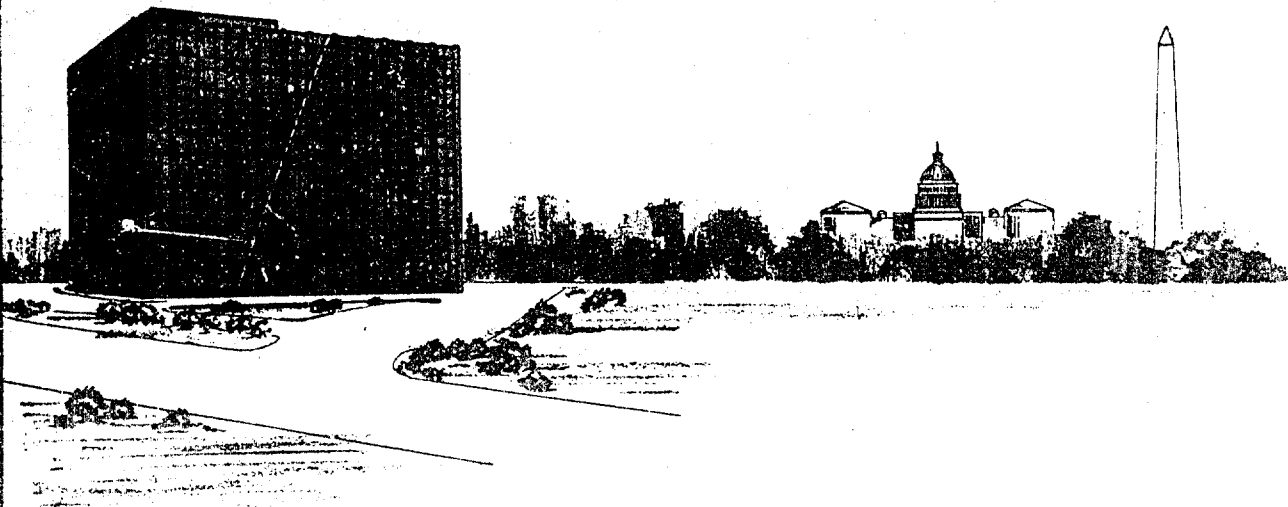
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# Effects of Drugs on Human Performance:

## The Effects of Scopolamine on Representative Human Performance Tests

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**Technical Report 1**  
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Effects of Scopolamine on  
Representative Human Performance Tests

by

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TECHNICAL REPORT 1

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## PREFACE

The present report describes research carried out by the American Institutes for Research, Washington Office, with the collaboration and support of the Psychology Branch, Experimental Medicine Division, Medical Research Directorate, U. S. Army Chemical Research and Development Laboratories, Edgewood Arsenal, Maryland. The project was administered within A.I.R.'s Skills Research Program, of which Dr. Harold P. Van Cott is Director.

Dr. Edwin A. Fleishman, Director of A.I.R.'s Washington Office, was Principal Investigator on the project. He provided overall direction, technical supervision of the research, and assisted in the editing of the report. Robert Kaplan served as research assistant and Jack Wagener, Laurence Drell, Robert Shilkert, and Thomas Tropp served as test administrators. Mrs. Nancy Brown and Mrs. Doris Donohue provided administrative and secretarial help.

At CRDL's Psychology Branch we acknowledge the support and assistance of Dr. Edward Stearns, who served as Contract Project Officer, Lt. Harlan Linsley, CRDL Liaison Officer, and Sp 4 Christopher Sieger, Test Administrator. Finally, we would like to acknowledge the medical support provided by the Clinical Research Division, particularly in the Psychopharmacology Branch, headed by Maj. James Ketchum.

## DIGEST

The present report is the first on a series of research studies aimed at developing a comprehensive battery of ability tests to evaluate the effects of drugs on human performance.

Tests comprising a preliminary sub-battery were selected and developed to sample a broad range of human abilities in four categories. Two ability tests were chosen within each category as follows:

Visual Acuity and Time Estimation as measures of Sensory-Perceptual abilities;

Reaction Time and Manipulation as measures of Psychomotor abilities;

Grip Strength and Balance as measures of Physical Proficiency abilities;

Short Term Memory and Addition as measures of Cognitive abilities.

The effects of a 12 gamma/kg. dose of Scopolamine on each performance test were studied with the following results:

1. The tests selected were sensitive to Scopolamine, which generally led to poorer scores on each of the performances measured.
2. Performance in general was poorest from two to four hours after the drug was administered.
3. Among the abilities studied, Visual Acuity (Near) was most severely affected, while Grip Strength, Reaction Time and the accuracy of Time Estimation were only slightly affected.
4. Exceptions to these general findings exist; they cannot be indiscriminately generalized. For example, 3/4 hours after drug administration, both Manipulation and Balance were more severely affected than Near Visual Acuity. The value of using separate ability measures is thereby demonstrated insofar as drug effects depend, at least in part, on the particular ability tested.

It was concluded that the results were encouraging for continued development of the battery through modifications of existing tests and establishment of new tests.

Furthermore, it was recognized that the ultimate value of the ability tests developed would lie in the extent to which predictions could be made about drug effects on operational military tasks from drug effects on the component abilities studied in the laboratory.

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## I. INTRODUCTION

The research reported here is the first on a series of studies of the effects of chemical compounds on human performance, conducted by the American Institutes for Research (AIR) with the support of the U. S. Army's Chemical Research and Development Laboratory (CRDL).

The overall goal of the project is the development of a comprehensive test program for evaluating the effects of chemical compounds on human performance. The project aims at providing a reliable and controlled means of predicting from drug effects in laboratory testing to effects in military operations.

This first report concentrates on the initial phase of the research program which established tests and testing procedures for studying the effects of a chemical agent on the performance of tests of a sample of basic human abilities. The agent was Scopolamine ( $12\gamma/\text{kg.}^1$ ), and the tests were representative of four major areas of human performance categorized as Psychomotor, Physical Proficiency, Sensory-Perceptual, and Cognitive.

The sample was selected from a more comprehensive preliminary set of ability tests, which had been carefully chosen following a survey of existing ability tests. The full list of tests recommended for exploration and possible subsequent development is included in the First Quarterly Report (AIR Report E-25-1, 15 October 1964).

Wherever possible, previous factor analysis information was used to guide the choice. The general rationale underlying all test selection, and underlying the identification of the abilities themselves is concisely presented in the First Annual Summary Report of the current research (15 September, 1965).

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1.  $\gamma$  = gamma = number of micrograms. Thus  $12\gamma/\text{kg.}$  = 12 micrograms per kilogram of body weight.

## II. METHODOLOGY

### A. Test Battery:

The tests chosen for the study were selected because they incorporated the following features:

- a) they were believed to be representative of the aforementioned categories of human ability performance;
- b) they were easy to administer and score;
- c) they could be conducted within relatively brief testing periods;
- d) they were repeatable (i.e., Ss could not learn to perform them correctly);
- e) they were consistent with the safety requirements of the volunteer subjects.

Table 1 presents the tests selected, two tests representing each of the ability categories listed. A brief description of each of the tests presented in order of administration follows. Except for the Standard Challenge, the name of the ability is presented first. The test name, which follows in parenthesis, is the one used thereafter to describe the particular test of the ability involved.

STANDARD CHALLENGE: S was shown a 3 x 5 card containing a letter or number. He was first asked to name the card, then take it, and then place it on its corresponding space on a board containing all the letters and numbers. If the S did not name or take the card, he was still asked to indicate the location of the corresponding space. If the S failed to comply with all of the above instructions, he was considered untestable for the Test Session. Compliance with any one of the challenges was evidence for the existence of the minimal level of subject awareness and Experimenter-Subject rapport required to meaningfully pursue the remainder of the tests.

VISUAL ACUITY (Near Visual Acuity; Far Visual Acuity): A modified Bausch & Lomb Orthorator test of Near and Far Acuity was developed. The task was the identification of the location of a checkerboard design in progressively smaller target squares, and the score was the smallest acuity level correctly identified.

Two Far Acuity and two Near Acuity thresholds were recorded during each session. The average for each threshold was used as the S's score.

TABLE I

Performance Battery Tests

Category	Ability	Test	Allowable Administration Time (in minutes)
Sensory/ Perceptual	1. VISUAL ACUITY	ORTHORATOR (near & far)	4
	2. TIME ESTIMATION	EMPTY INTERVAL JUDGMENTS (10 secs.)	4
Psychomotor	3. REACTION TIME	SIMPLE R. T.	3
	4. MANUAL DEXTERITY	MINN. RATE OF MANIP. (Displacement)	3
Physical Proficiency	5. STATIC STRENGTH	DYNAMOMETER	1
	6. GROSS BODY EQUILIBRIUM	BALANCE - A Test	2
Cognitive	7. NUMBER FACILITY	ADDITION	4
	8. SHORT TERM MEMORY	AUDITORY NUMBER SPAN	4
Total			25

Note: Each test session is preceded by a standard challenge.

MANUAL DEXTERITY (Manipulation): A modified form of the Minnesota Rate of Manipulation (Displacement) test, shown previously to measure Manual Dexterity was administered with a 30 sec. time limit. The S was required to move as many blocks as he could from one hole to an adjoining hole. The number of blocks moved was recorded on two successive trials. The average of the two trials was computed as the score.

STATIC STRENGTH (Crip Strength): A hand-grip dynamometer was attached to a table, beside which the S stood. The number of kilograms of pressure applied was recorded on two successive squeezes which were one minute apart. The greater pressure exerted was taken as the score. Previous studies had shown this measure to be diagnostic of a general static strength factor.

GROSS BODY EQUILIBRIUM (Balance): Fleishman's Balance-A test, shown previously to measure the Gross Body Equilibrium factor, was used. Ss were permitted however, to keep their eyes open and to use their arms for balance. Ss balanced on one foot for up to 20 secs. The time that the S balanced was recorded on two successive trials, and the average time balanced was computed as the score.

NUMBER FACILITY (Addition): The standard NF test was administered in a sequence modified to ensure homogeneity of difficulty in the experimental sessions.

The number of problems correctly solved in a 3 minute test period was recorded as the score. The Addition test consistently loads on the Num' r Facility factor.

SHORT TERM MEMORY (Auditory Number Span): Sixteen series of numbers, each consisting of pairs of 3-digit to 9-digit groups, were recorded on tape. (e.g., a pair of 3-digit numbers followed by a pair of 4-digit numbers, etc., up to a pair of 9-digit numbers )

The S's task in each session was to repeat the numbers he heard. The difficulty increased from the 3-digit to the 9-digit level, and the highest level correctly repeated was recorded as the score.

TIME ESTIMATION (Empty Interval Judgements by Production): Subjects practiced counting to themselves from 1 to 10 to estimate a 10 second interval. They were given 10 trials during the Orientation Session on which they had feedback as to what their actual estimate was. No feedback was given in later sessions.

During each test session, each Subject was given five "no feedback" trials on which the actual time estimated as 10 seconds was recorded. Two measures were derived:

- a) the average of the five estimates of a ten-second interval;
- b) the variance of the five estimate scores around the mean time estimate.

REACTION TIME (Visual Reaction Time): Simple reaction time to a light stimulus was recorded for 2 trials, each trial consisting of 10 stimulus presentations. The score was the average RT of the 20 presentations. A large number of previous studies demonstrate that this type of visual reaction time measure loads on a general Reaction Time factor.

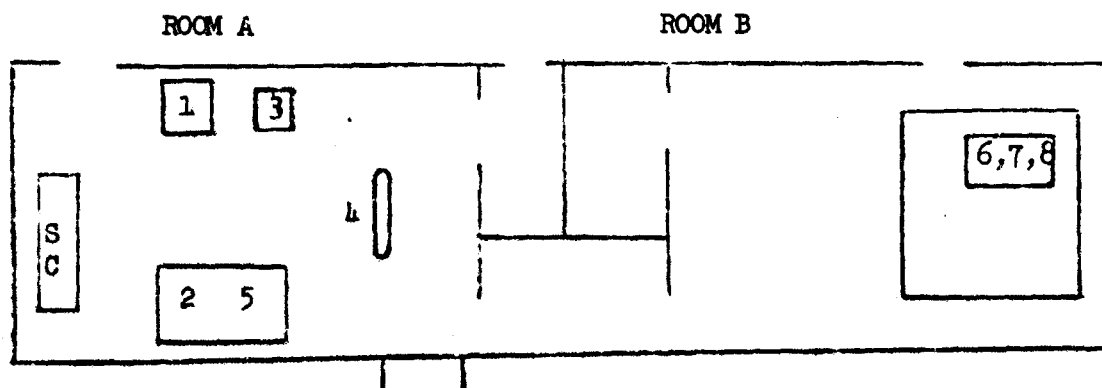
The basic instructions for each of the tests are included as Appendix A. For each test, an explanation of the task and instructions to the S were given in the Orientation. Slightly modified instructions for the Baseline Testing and Experimental Testing are also included. These consist of simplified instructions for Baseline Testing, and repetitive instructions for Experimental Testing to allow for possible Subject unresponsiveness. Each procedure incorporated a time constraint so that a test had to be completed in a fixed time period. Allowances were made for subject unresponsiveness by calling for a repeat of basic instructions. If, within a fixed time limit, the S still did not respond, the test was terminated and he proceeded to the next test.

B. Procedure:

The tests were conducted in two rooms in CRDL's Human Performance Test Laboratory. Both rooms had acoustic-tile ceilings and one contained a soundproof IAC chamber.

Figure 1 illustrates the allocation of test space for the study. The numbers are keyed to the tests, and represent the sequence in which the tests were run. Five tests were conducted in Room A and three in the chamber in Room B. Testing in each room took about 15 minutes and a staggered schedule was developed so that when one S moved from Room A to Room B, a second S entered Room A.

The time taken for a given S to run through the 8 tests was called a Test Session, and each Session began with a Standard Challenge designed to assess the cooperation of the S. The test sequence was fixed, with one Test Administrator giving the tests in Room A and another in Room B.



KEY:

- |                        |                  |                         |
|------------------------|------------------|-------------------------|
| SC. Standard Challenge | 3. Grip Strength | 6. Memory               |
| 1. Visual Acuity       | 4. Balance       | 7. Time Estimation      |
| 2. Manual Dexterity    | 5. Addition      | 8. Simple Reaction Time |

Fig. 1. Location of tests in the laboratory.



Four groups of four Ss were studied. However, one S was unavailable for the first group in which only two Ss received Scopolamine.

Two groups were begun on a Monday and two on a Wednesday of each of two successive weeks. The first day for each group was devoted to Orientation and Baseline Testing, and the second day was devoted to Experimental Testing.

Table 2 presents a diagram of the overall testing schedule.

TABLE 2. Subject Treatment Schedule

Treatment	Week 1				Week 2			
	Gr. I		Gr. II		Gr. III		Gr. IV	
	Mon.	Tu.	Wed.	Th.	Mon.	Tu.	Wed.	Th.
Orientation & Baseline Testing	3		4		4		4	
Experimental Testing		1		1		1		1
		2		3		3		3

Ss were allowed 1 hour each for orientation, and 1/2 hour each for all subsequent test sessions. Orientation and four baseline sessions were run on the first day; a fifth baseline (preceding Dose Administration<sup>2</sup>) and five experimental sessions (after Dose Administration) were run on the second day.

Ample rest and meal times were provided for in the schedule which is presented in Appendix B, Table 6.

2. Dose Administration (D) was by intra-muscular injection.

C. Subjects:

The 15 Ss were medical volunteers drawn from the 1st and 2nd Army Areas. Background information on the S including their rank, date of birth, highest educational grade completed and military speciality is summarized in Appendix B, Table 5.

The Placebo group contained 3 Pfc.'s and one Specialist; the Scopolamine group contained 6 Pfc.'s, 3 Specialists, 1 Private and 1 Sergeant.

Ages ranged from 20 to 26, and highest grades completed ranged from 11th to 15th.

Subject screening was conducted by the Clinical Research Division of CRDL's Medical Research Directorate. The screening, which determined the eligibility of Ss for various compounds, included consideration of subject information drawn from a Personal and Medical History, a Psychiatric Interview, and the Minnesota Multiphasic Personality Inventory.

D. Statistical Treatment:

Several statistical analyses were performed on the data to answer questions about the effects of Scopolamine on test performance.

For each test, the mean and standard deviation at each session was computed for the 11 Scopolamine and the 4 Placebo Ss. A Baseline Value (B) was computed as the average of the last two baseline scores, thereby best representing the pre-drug performance by minimizing practice effects. The data which provide the basic findings of the study are presented in Tables 3a and 3b. Table 3a presents the Means and Standard Deviations of performance on the Orientation and the five Baseline Sessions; Table 3b presents the same measures for the Baseline Value and the five Dosage Sessions.

Additionally, a Z-score was computed to provide a basis for comparison across tests. For each test, the score reflects the post-drug performance value in terms of its relation to the distribution of pre-drug Baseline Values. (See Table 4).

Several statistical analyses were conducted to examine the effect of Scopolamine on each performance test:

- (1) Baseline Values vs. Drug Scores (e.g., Subjects acting as their own control in the Scopolamine and in the Placebo Groups.)
- (2) Placebo Groups vs. Scopolamine Groups

The first set of tests indicated the degree to which each of the two group's performance was changed from its Baseline Value as a function of the dosage sessions.

The second set of tests, in providing a control group, indicated the extent to which the significant differences found above could reasonably be attributed to the drug.

In the first set of tests, analyses of variance were performed to test the significance of differences among experimental test sessions for the Placebo and the Scopolamine Ss. Where F-tests indicated significant differences, individual Sandler's A tests<sup>3</sup> were conducted to determine whether each session score differed significantly from the Baseline Value. (See Table 7).

3. In Sandler, J.A. A test of the significance of the difference between the means of correlated measures, based on a simplification of Student's t. Brit. J. Psychol., 1955, 46, 225-227.

In the second set, a series of t-tests compared the differences between the Placebo and Scopolamine groups (See Table 8).

Where significant differences appeared in both sets of tests, the change in performance could most likely be attributed to the drug. Where significant differences appeared in the Subjects-as-their-own Control tests, but not in the Placebo comparison tests, the drug's effect as the agent inducing the change was less certain. Possible effects on performance of "second-day" factors (e.g., weather, fatigue, boredom, amount of sleep, etc.) must always be recognized.

A note of caution is offered regarding the degree to which generalization may be made from small sample studies such as the present one. Extrapolations are only legitimate to the extent that the present volunteer sample is, in fact, representative of the population of interest (e.g., Army enlisted men). Although there is no reason to doubt the present group's representativeness, future testing with more volunteers will be required before generalizations can confidently be made to the enlisted military population at large.

Furthermore, it is recognized that the statistical analyses employed in the present report are not exhaustive; they present instead an initial overview of the data generated by the research. For the sake of expediency in presenting the major findings, extensive analyses of differing statistical types were not undertaken at this time. For example, the results concentrate on the overall effects of the agent and do not consider individual differences.

Continuing analyses are in progress, and relevant findings will be reported in subsequent papers and reports.

### III. RESULTS AND DISCUSSION

The results presented in Table 3 are pictorially represented by the graphs in Figures 2-11 showing the performance of the Placebo and Scopolamine groups before and after Drug Administration. Figure 12 presents the graphic representation of Table 4 showing the relative effects of Scopolamine on the different tests.

#### A. Effects of Scopolamine on Individual Test Performance

Each of the curves shows the effects of an intra-muscular injection of Scopolamine on performance on a particular test. The curves for each treatment group (i.e., Scopolamine and Placebo) are divided into two parts showing the trend on the first day and on the second day. The point between the two days represents the Baseline Score (B) computed as the average of the last score on the first day (b<sub>4</sub>) and the first score on the second day (b<sub>5</sub>). The time of injection or Dose Administration (D) is shown on the second day falling between b<sub>5</sub> and the first dosage session (d<sub>1</sub>).

Whereas the horizontal scales are the same for all tests indicating the time and sequence of test sessions, the vertical scales differ according to the performance measure used for each of the different tests. The fact that some of the vertical scales are ascending while others are descending is due to the desirability of uniformly representing decrements in performance as a drop in the curve.<sup>4</sup>

A cursory look at all the curves showed several major trends:

- a) Stability of baseline scores was generally reached by the end of the first day's testing.
- b) The Placebo and Scopolamine groups did not differ greatly prior to the drug administration.
- c) Scopolamine generally caused a decrement in performance with scores tending to return to baseline levels by the time of the 5th post-drug session, 8 3/4 hours after drug administration.
- d) Performance generally deteriorated steadily and was poorest on the second post-drug test session (d<sub>2</sub>: 2 1/4 hrs. after injection); however, some performance measures were poorest at d<sub>1</sub> (3 1/4 hrs. after injection) and others were poorest at d<sub>3</sub> (4 1/4 hrs. after injection).

<sup>4</sup>. The only exception to this rule is for the Time Estimate curve which plots the actual time estimated as 10 secs., and for which decrement in performance would be indicated by the amount of deviation from the true estimate of 10 secs.

The statistical analyses via F-tests and A-tests examined the hypothesis that differences in scores were a function of the differing test sessions for the Placebo and Scopolamine groups. Appendix C, Table 7 presents the results of these analyses.

Placebo: The analysis of variance of the dosage session scores showed that Manipulation was the only test on which Placebo performance differences were significant on the differing test sessions. The d5 session score was significantly higher than the Baseline Value with Manipulation, indicating that learning or facilitation had occurred. No other test showed such significant learning effects for the Placebo Group.

Scopolamine: The analysis showed a significant change in performance for every score except the variance measure derived from the Time Estimate performance. Every significant change but one indicated a decrement in performance due to the drug. The exception is the d5 Reaction Time score in which reaction time was significantly faster than the Baseline Value.

The t test analyses examined the significance of the difference between the Placebo and Drug groups during each test session. Appendix C, Table 8 presents these test results.

Baseline Sessions: None of the differences between the two groups' baseline scores was significant. Thus, there is evidence that the groups were effectively "matched" before drug administration.

Dosage Sessions: Significant differences between Drug and Placebo groups appeared during at least one test session for all performance tests except Grip Strength and the two Time Estimation measures.

Differences between Drug and Placebo groups were most significant for the Addition and the two Visual Acuity measures; significant differences generally continued to appear throughout the five post-drug test sessions. On the other hand, some tests (e.g., Balance and Reaction Time) showed significant differences in early test sessions but not in later sessions.

A more detailed look at the tests in relation to each other follows an analysis of each of the tests.

In discussing drug effects in this report and subsequent reports, analyses with respect to physiological causation and effects will be minimized. While the desirability of thoroughly understanding drug effects in terms of an integrated view of the behavioral, the physiological, and ultimately, the neurochemical levels of drug action is recognized, this series of reports will concentrate on the performance aspect of drug effects.

TABLE 3

## TEST MEANS AND STANDARD DEVIATIONS FOR TREATMENT GROUPS

a. (Orientation and Baseline Sessions)

Name of Test	0		b1		b2		b3		b4		b5	
	Mean	S. D.	Mean	S. D.	Mean	S. D.	Mean	S. D.	Mean	S. D.	Mean	S. D.
Visual Acuity (Far)	Scop. 1.08 Plac. .97	.24 .10	1.07 .93	.27 .12	1.06 .91	.26 .08	1.07 .92	.31 .10	1.08 .90	.35 .07	1.06 .90	.24 .07
Visual Acuity (Near)	Scop. 1.01 Plac. .91	.33 .11	.95 .94	.17 .14	.93 .90	.21 .11	.94 .93	.14 .12	.95 .89	.24 .12	.94 .91	.17 .11
Manipulation (Average)	Scop. 39.0 Plac. 37.8	4.18 6.84	40.9 39.4	3.88 7.92	42.5 41.6	4.62 6.32	43.1 40.0	5.11 6.77	43.7 42.8	5.64 7.14	41.7 41.6	5.12 5.84
Grip Strength (Best)	Scop. 54.5 Plac. 57.8	7.03 11.53	55.6 58.2	7.29 12.23	57.7 58.0	6.11 12.11	55.7 55.2	7.71 10.63	55.5 58.5	8.36 13.80	54.5 58.2	10.12 12.61
Balance (Average)	Scop. 17.1 Plac. 15.6	5.10 6.41	17.1 16.8	5.05 6.30	17.9 16.9	3.06 4.89	18.0 17.8	3.43 3.76	18.2 18.0	4.69 4.05	18.8 17.8	2.44 3.31
Addition (# correct)	Scop. 36.1 Plac. 33.0	9.16 8.76	39.9 34.2	10.97 5.91	38.2 31.2	10.15 6.29	39.2 33.2	11.08 8.92	41.2 36.8	9.41 6.55	41.2 36.8	10.92 5.44
Memory Span	Scop. 6.5 Plac. 5.8	1.37 .96	6.7 5.2	1.01 1.50	6.5 6.8	1.13 1.50	7.0 6.5	.89 1.91	7.0 6.5	.89 1.91	7.1 6.2	.83 1.71
Time Est. (Mean)	Scop. 10.27 Plac. 9.20	.46 .98	9.68 10.75	.71 .57	9.97 10.22	.98 1.07	9.91 10.32	.84 1.04	9.96 10.24	1.04 .39	10.31 10.55	1.43 .58
Time Est. (Variance)	Scop. .581 Plac. .720	.59 .65	.489 .766	.26 .47	.605 .693	.81 .73	.462 .667	.55 .54	.304 .248	.20 .20	.618 .659	.60 .67
Reaction Time (Average)	Scop. .235 Plac. .222	.03 .01	.223 .219	.02 .02	.228 .228	.02 .02	.223 .222	.03 .01	.228 .228	.03 .03	.224 .233	.02 .02

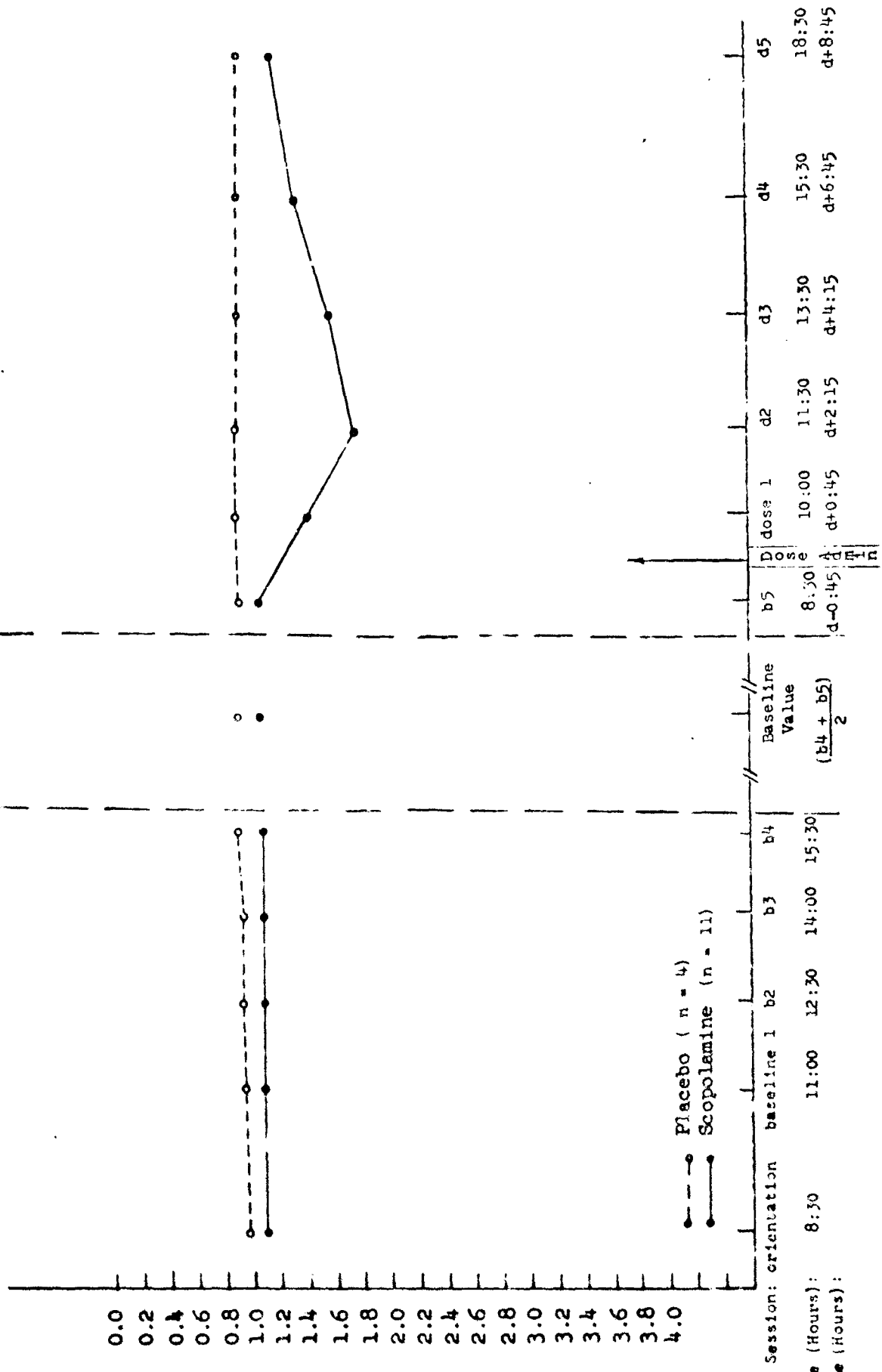


TABLE 3  
TEST MEANS AND STANDARD DEVIATIONS FOR TREATMENT GROUPS  
b. (Baseline Score and Drug Sessions)

Name of Test	Tripart.	B		d1		d2		d3		d4		d5	
		Mean	S. D.	Mean	S. D.	Mean	S. D.	Mean	S. D.	Mean	S. D.	Mean	S. D.
Visual Acuity (Far)	Scop.	1.07	.29	1.40	.52	1.75	.66	1.58	.85	1.32	.49	1.17	.32
	Plac.	.90	.07	.88	.06	.88	.06	.89	.07	.88	.06	.88	.04
Visual Acuity (Near)	Scop.	.94	.20	1.31	.70	3.32	2.64	3.78	3.35	2.52	2.63	1.69	1.11
	Plac.	.90	.11	.93	.12	.94	.14	.91	.11	.89	.08	.93	.13
Manipulation (Average)	Scop.	43.7	5.16	26.4	3.60	26.3	7.00	32.7	5.00	39.2	5.13	43.0	5.22
	Plac.	42.7	6.96	46.0	8.58	46.4	9.98	43.0	7.04	45.0	8.72	48.8	9.56
Grip Strength (Best)	Scop.	55.0	8.84	48.3	9.30	50.5	9.86	51.5	9.56	54.0	9.39	57.0	8.07
	Plac.	58.4	13.17	58.2	14.77	58.2	17.11	56.5	17.79	56.8	16.30	58.0	17.72
Balance (Average)	Scop.	18.5	2.98	5.1	3.55	8.8	4.93	14.7	3.46	17.3	3.63	18.1	3.37
	Plac.	17.9	3.55	18.8	2.00	20.0	0.00	18.4	3.10	20.0	0.00	20.0	0.00
Addition (# correct)	Scop.	41.2	10.01	19.5	14.11	4.6	7.25	8.7	11.66	17.3	16.35	25.7	16.88
	Plac.	36.8	5.87	40.2	5.25	36.0	6.98	37.0	6.22	37.0	5.94	37.0	6.27
Memory Span	Scop.	7.0	.79	5.6	.81	5.1	.94	5.5	1.29	6.5	.93	6.1	.83
	Plac.	6.4	1.75	7.0	1.41	6.8	.96	7.5	2.38	6.8	1.50	6.8	2.06
Time Est. (Mean)	Scop.	10.14	1.11	8.70	1.11	9.50	1.24	9.43	1.30	9.58	1.18	9.53	.90
	Plac.	10.40	.34	10.69	2.05	10.63	1.20	9.77	.88	11.07	1.87	9.84	1.25
Time Est. (Variance)	Scop.	.461	.33	.709	.61	1.588	1.82	1.306	1.40	.741	1.03	.556	.59
	Plac.	.454	.36	.550	.71	.452	.65	.324	.29	.419	.56	.543	.61
Reaction Time (Average)	Scop.	.226	.02	.327	.08	.396	.24	.259	.05	.232	.03	.211	.02
	Plac.	.230	.02	.223	.02	.221	.02	.242	.04	.221	.02	.210	.02

DAY 1

DAY 2



Real Time (Hours): 8:30  
 Exptl. Time (Hours):

Fig.2. Effects of Scopolamine (12  $\mu$ /kg.) on Visual Acuity (Far)

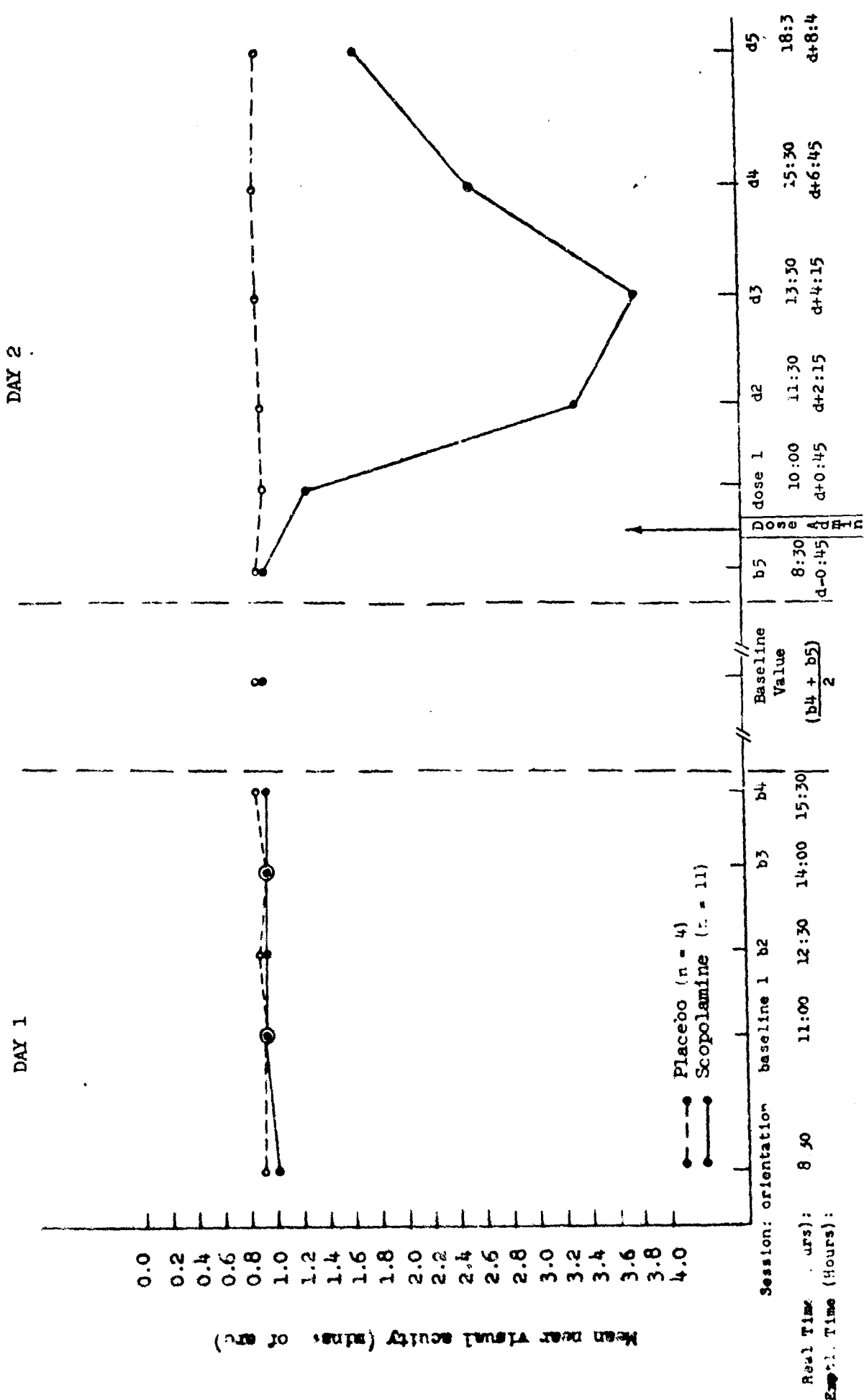


Fig. 3. Effects of Scopolamine (12 M/kg.) on Visual Acuity (Near)

DAY 1

DAY 2

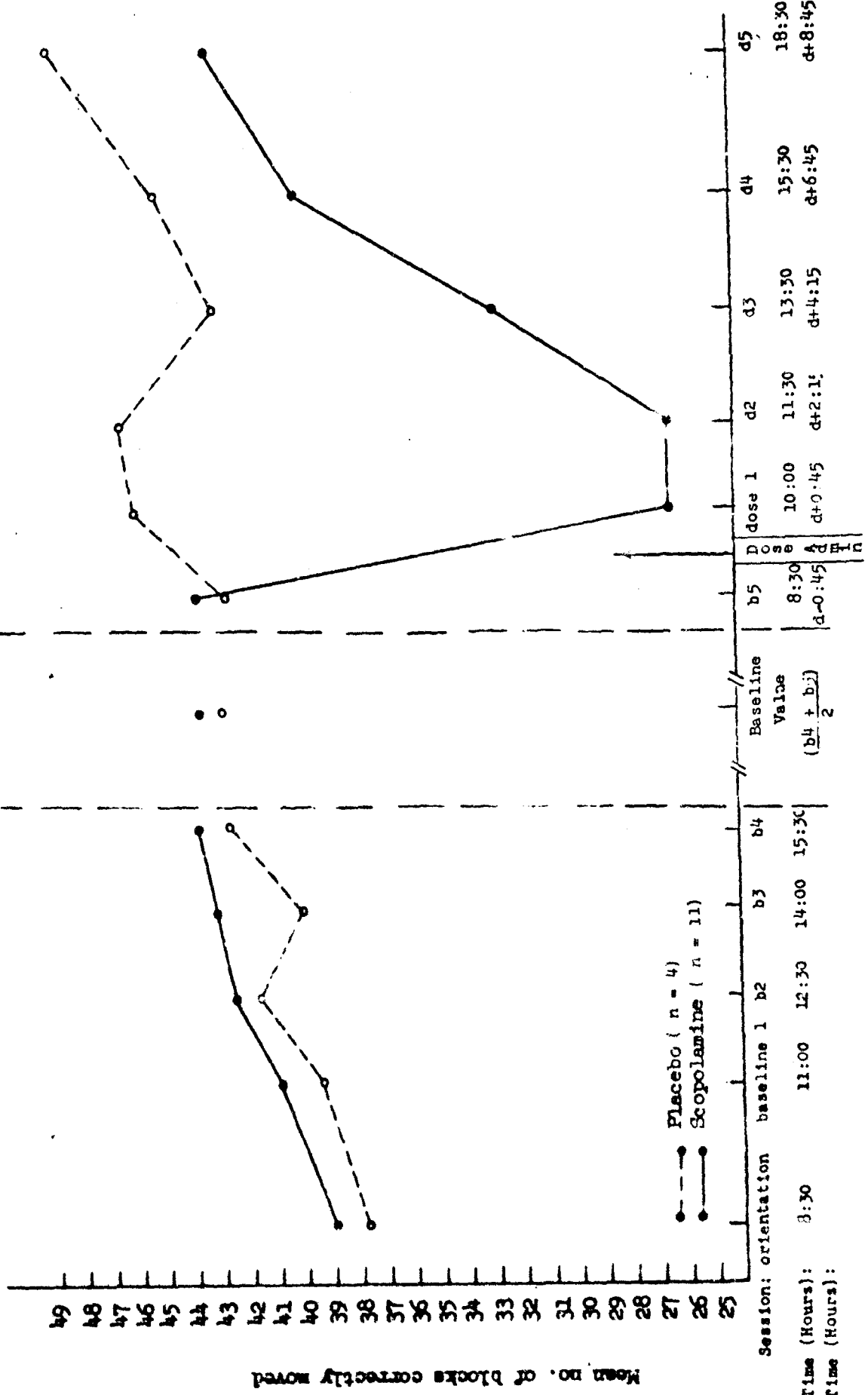


Fig. 4. Effects of Scopolamine (12  $\delta$ /kg.) on Manipulation

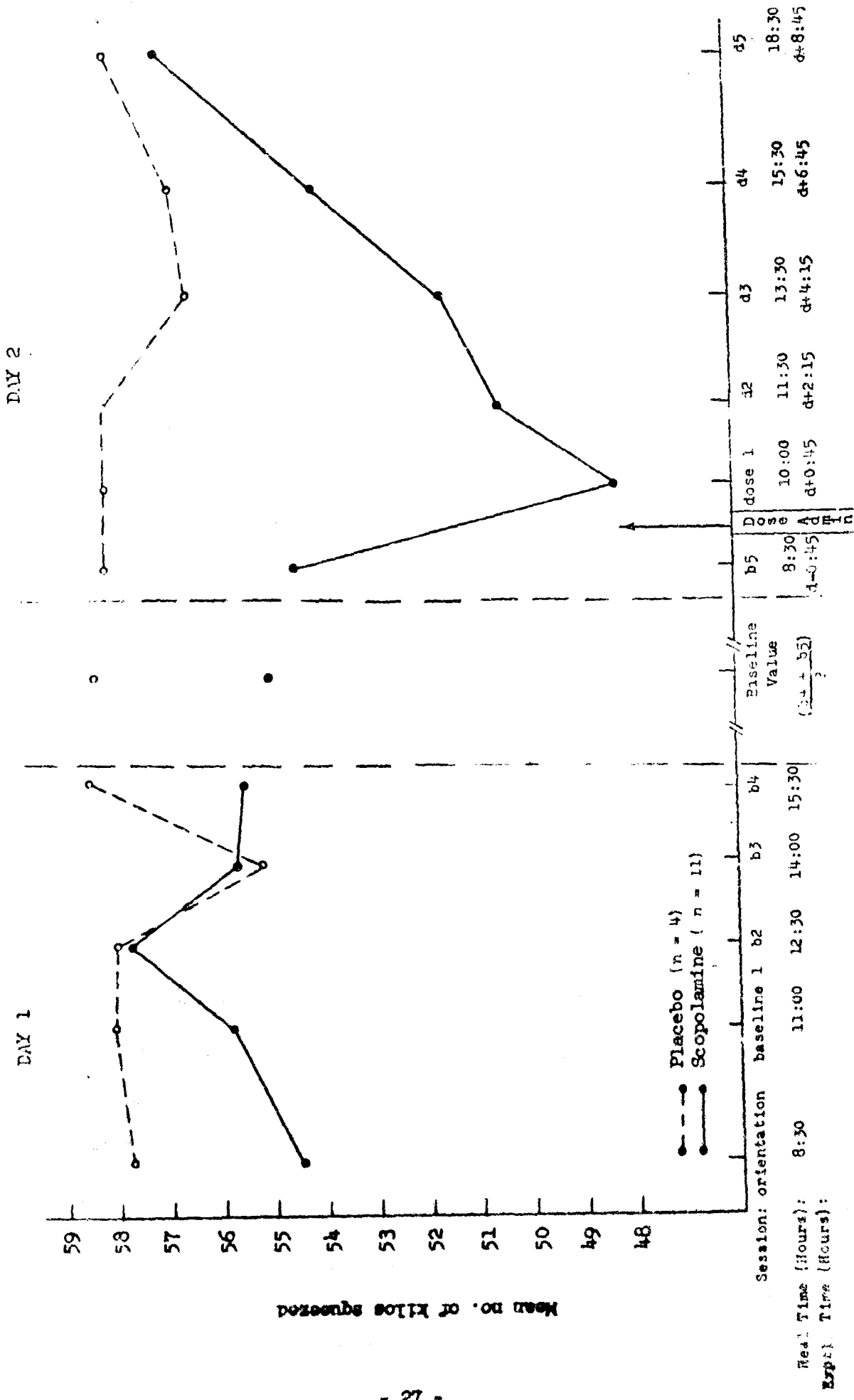


Fig. 5. Effects of Scopolamine (12 mg.) on Grip Strength

DAY 2

DAY 1

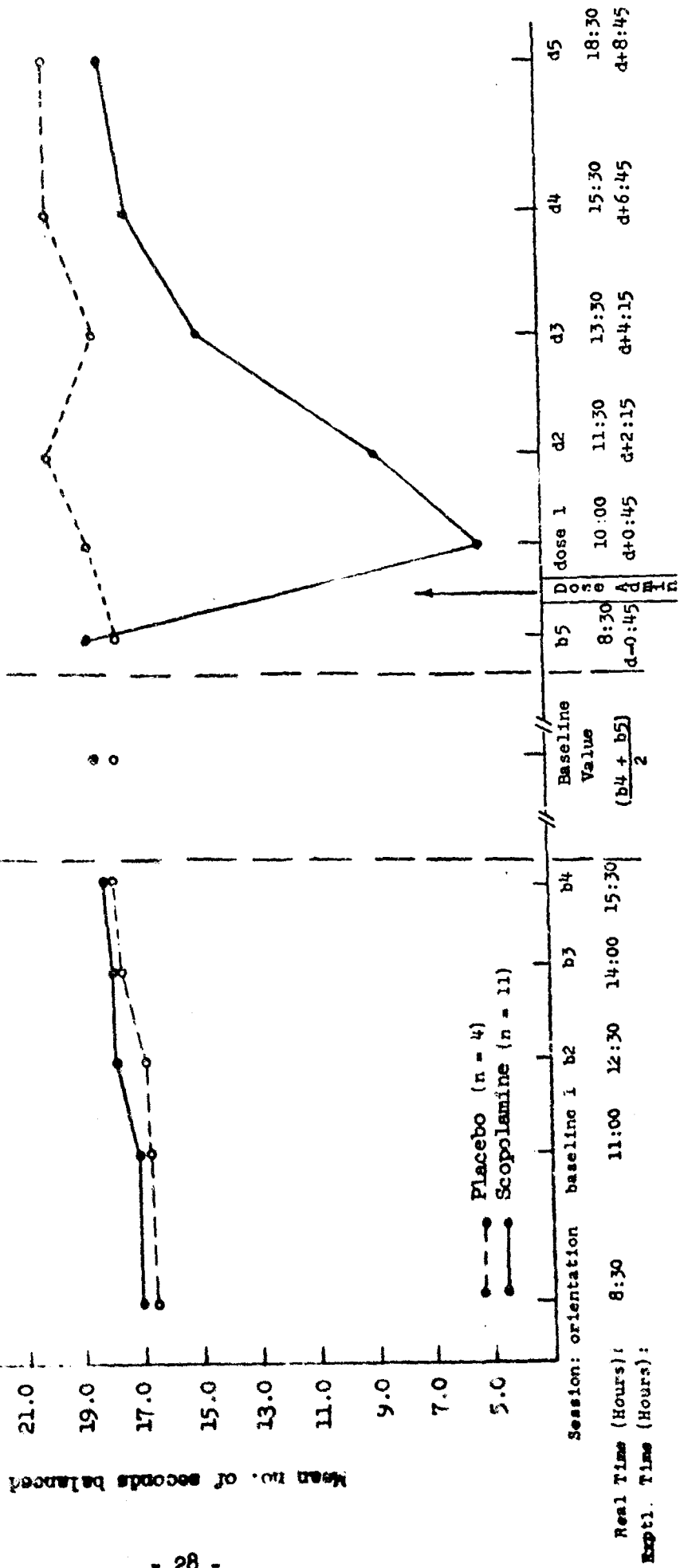


Fig. 6 Effects of Scopolamine (1 mg.) on Balance

DAY 2

DAY 1

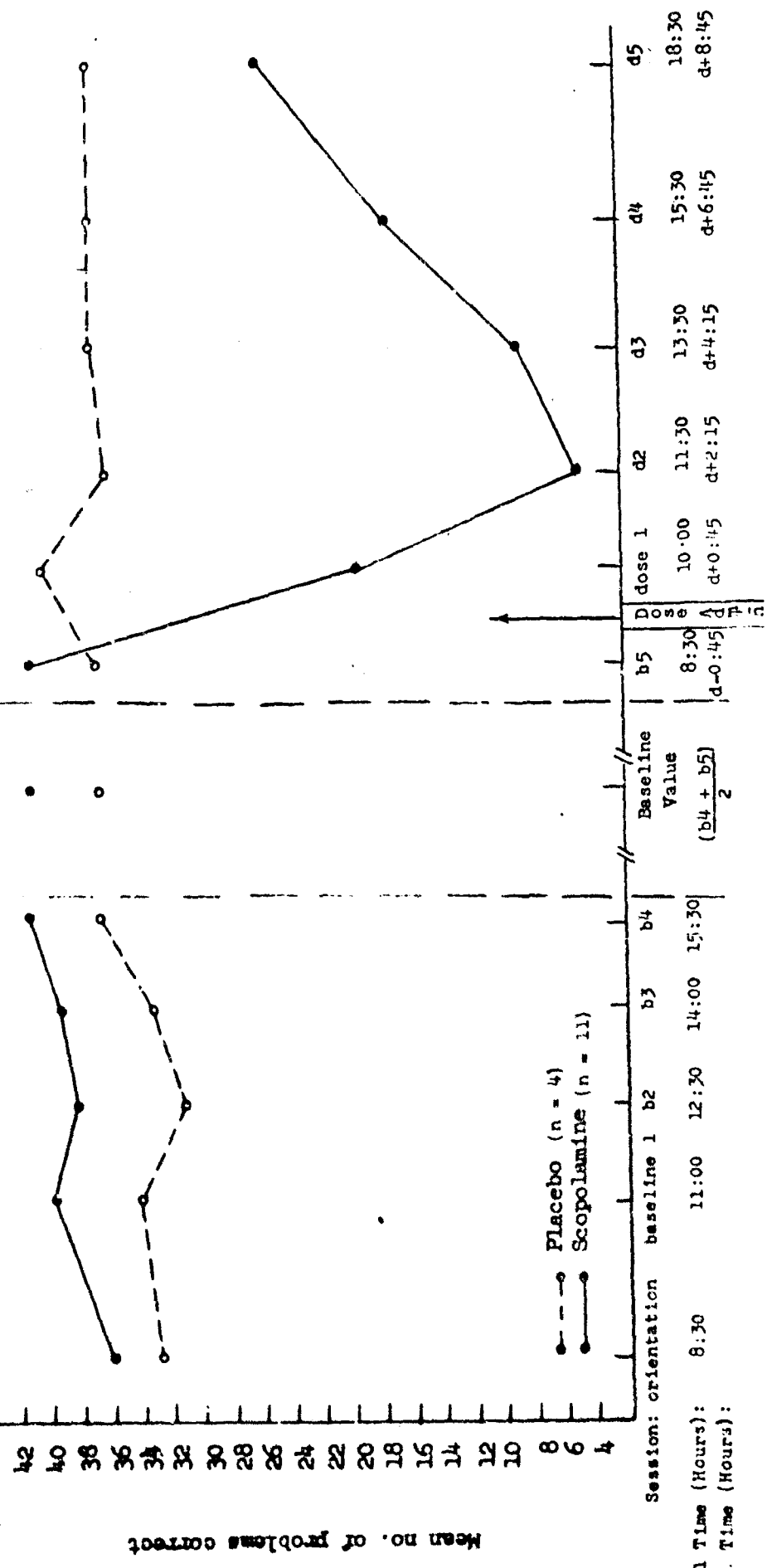


Fig. 7. Effects of Scopolamine (12 Y/23.) on Addition (Correct)

Real Time (Hours):  
Exptl. Time (Hours):

Mean no. of problems correct

DAY 1

DAY 2

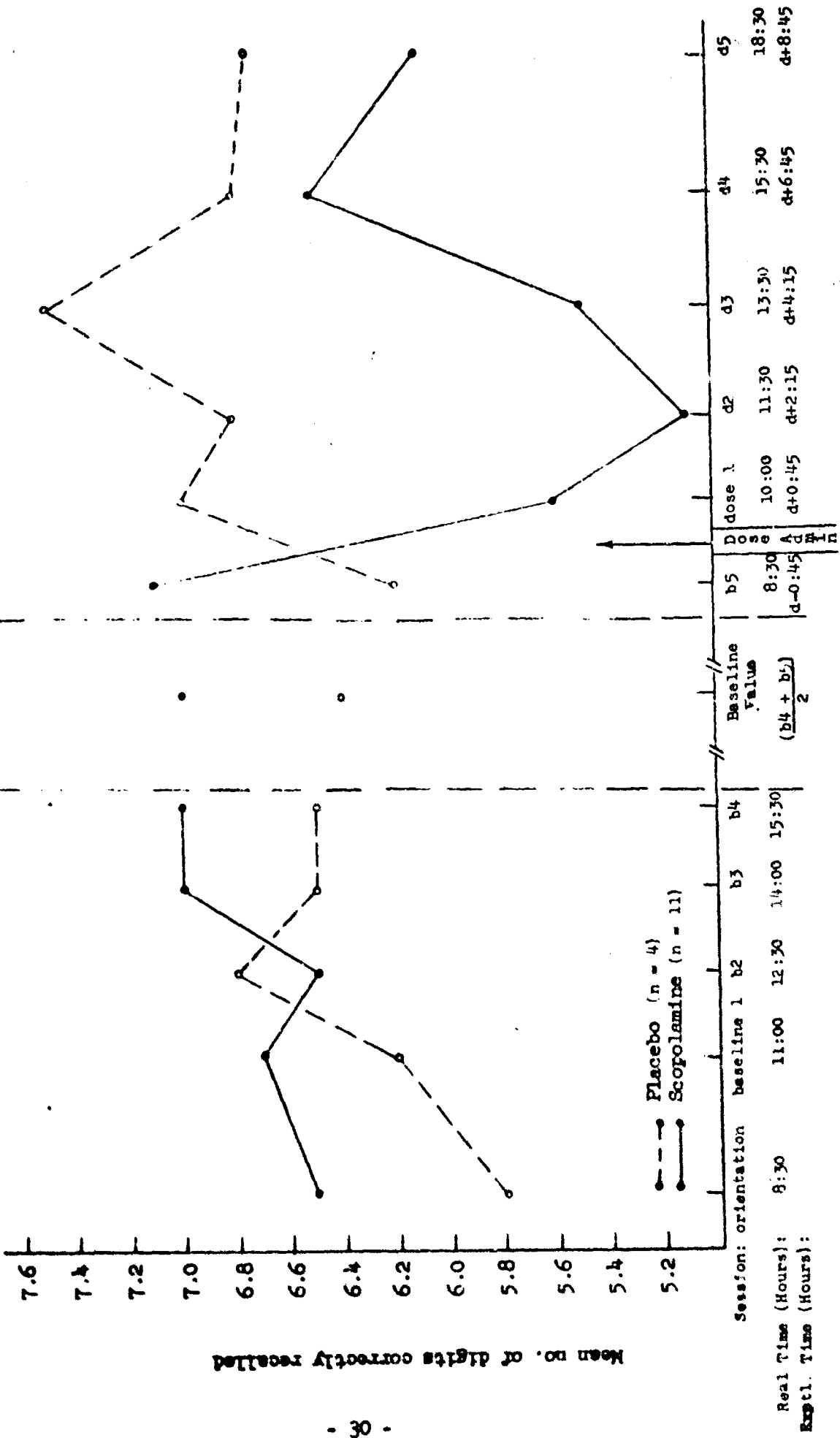


Fig. 8. Effects of Scopolamine (12  $\mu$ /kg.) on Memory Span



DAY 2

DAY 1

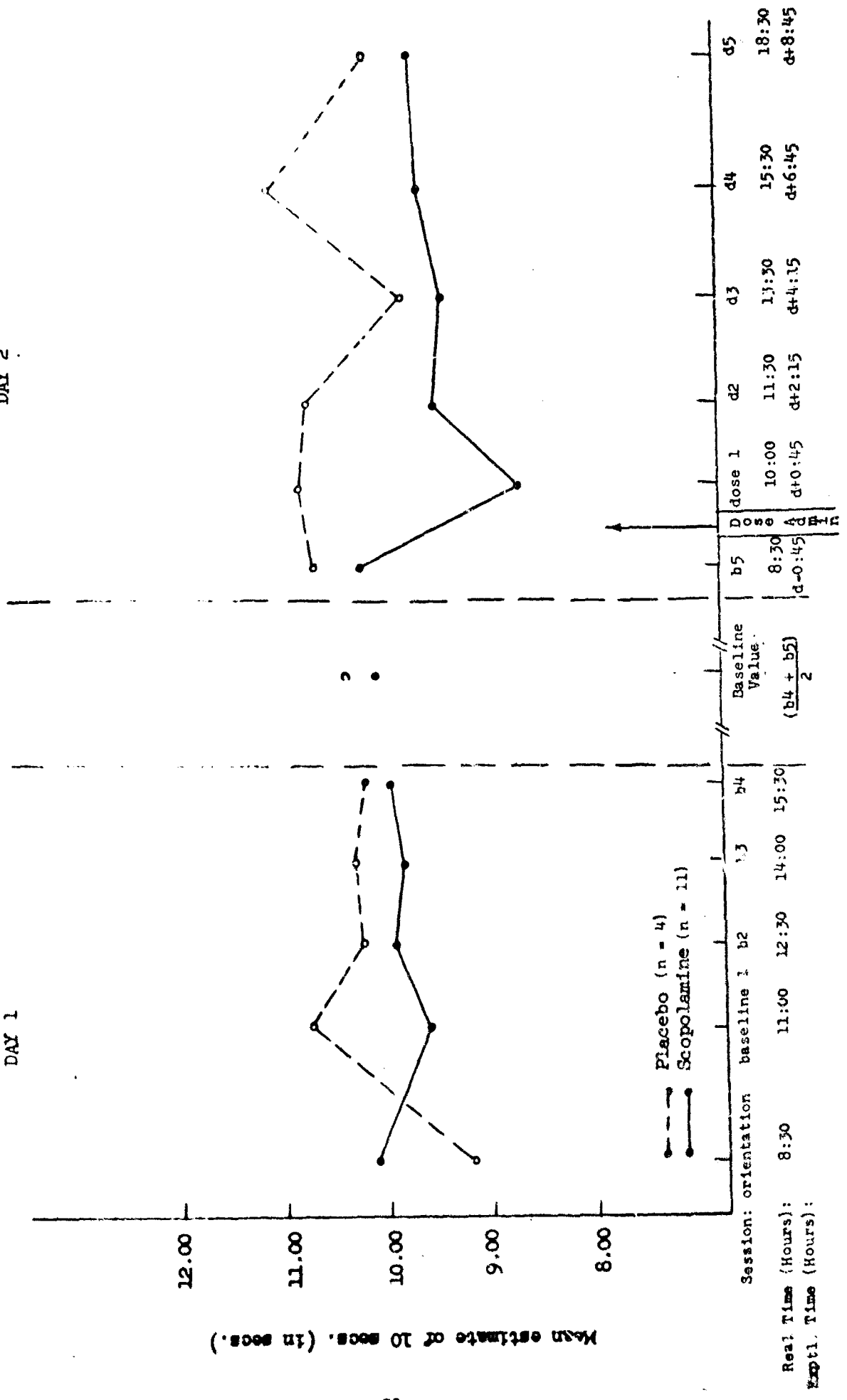


Fig. 9. Effects of Scopolamine (12  $\mu$ /kg.) on Time Estimation (Means)

DAY 1

DAY 2

Mean variance in estimating 10 secs. (in secs.)

.200  
.400  
.600  
.800  
1.000  
1.200  
1.400  
1.600  
1.800

---●--- Placebo (n = 4)  
---●--- Scopolamine (n = 11)

Session:	orientation	baseline 1	b2	b3	b4	Baseline Value	( $\frac{b4 + b5}{2}$ )	Dose	d1	d2	d3	d4	d5
Real Time (Hours):	8:30	11:00	12:30	14:00	15:30			8:30	10:00	11:30	13:30	15:30	18:30
Exptl. Time (Hours):								d-0:45	d+0:45	d+2:15	d+4:15	d+6:45	d+8:45

Fig. 10. Effects of Scopolamine (12  $\mu$ /kg.) on Time Estimation (Variability)

DAY 2

DAY 1

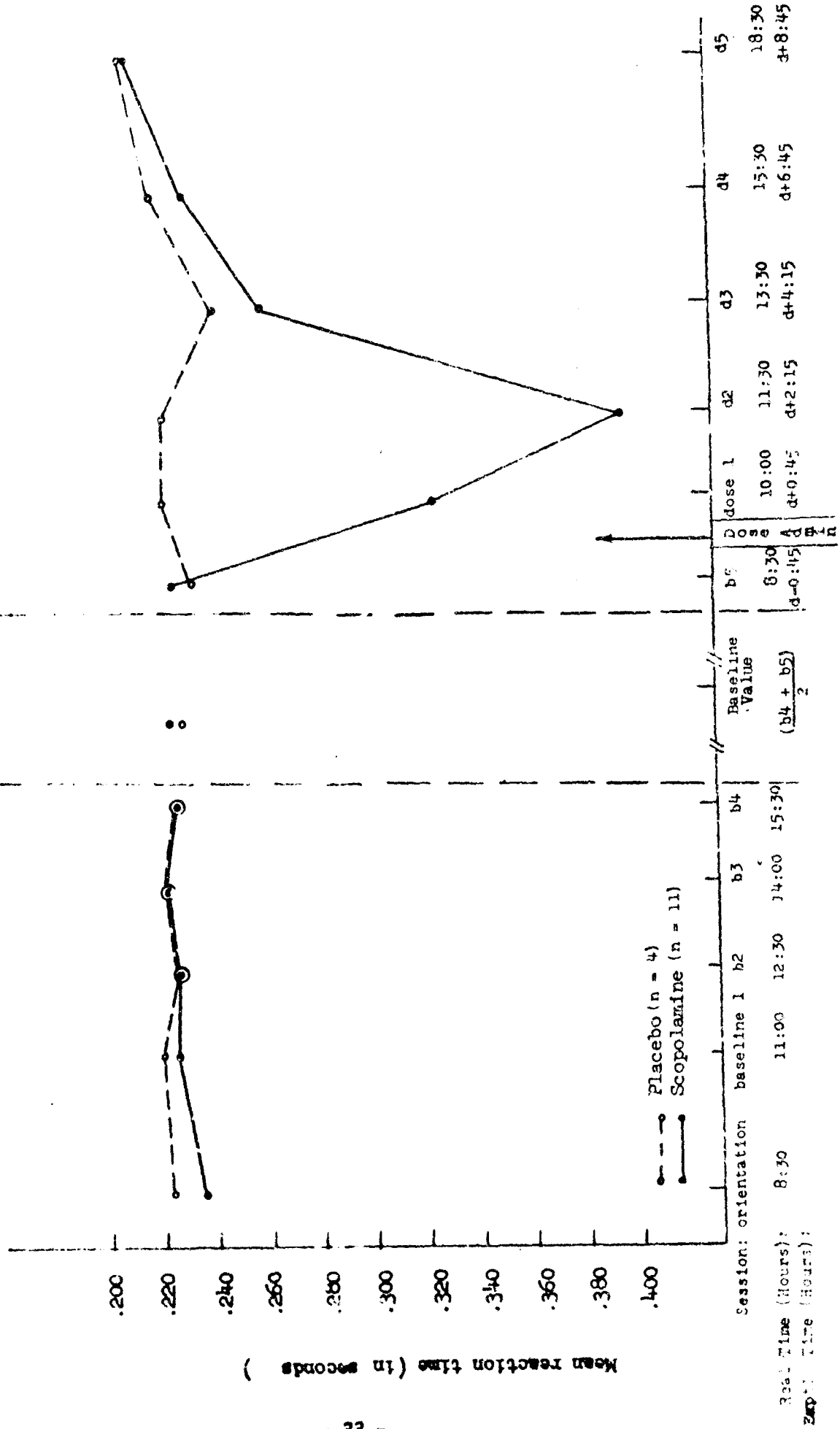


Fig.11. Effects of Scopolamine (12  $\mu$ /kg.) on Simple Reaction Time

### Visual Acuity

Both Far and Near Acuity may be considered simultaneously.

Figures 2 and 3, and Table 3 indicate the following:

1. In baseline testing, both Acuity scores were extremely stable and demonstrated normal acuity thresholds of about 1 min. of arc. (equivalent to 20/20 vision). Average Far Acuity thresholds ranged from .90 to 1.08 mins. of arc. Average Near Acuity thresholds ranged from .89 to 1.01 mins. of arc.

2. Near Acuity was affected far more severely than Far Acuity. Average Near Acuity thresholds increased from a Baseline (B) of .94 min. of arc to 3.78 min. of arc.; average Far Acuity thresholds increased from 1.07 to only 1.75 min. of arc.

3. Recovery of Far Acuity started sooner than Near Acuity. Poorest performance for Far Acuity was reached on the second session following Drug Administration; for Near Acuity it was reached on the third post-drug session. By the time of the fifth post-injection session, the Far score had almost returned to its Baseline (d5 threshold = 1.17 min. of arc.), whereas the Near scores still showed appreciable decrement, (d5 threshold = 1.69 min. of arc).

### Manipulation

Figure 4 and Table 3 show the following major findings with respect to performance on the Minnesota Rate of Manipulation Test of Manual Dexterity.

1. Learning was in evidence during the course of the two test days. In baseline testing the average number of blocks moved increased steadily from approximately 38 to 43. During the second day, averages for the Placebo Ss continued to increase to almost 49, which was significantly greater than the Baseline value of 42.7.

2. Scopolamine adversely affected Manual Dexterity. The number of blocks moved by the drugged Ss significantly dropped from a Baseline score of 43.6 to d1 and d2 scores of 26.4 and 26.3, respectively.

Later testing gave evidence of recovery until, at the d5 session, performance was back to a near-baseline level of 43.0.

### Grip Strength

Figure 5 and Table 3 contain the following major findings with respect to performance on the Dynamometer Test of Static Strength:

1. Undrugged testing was relatively stable although the Placebo subjects tended to perform slightly better than the Scopolamine subjects, providing an average score of 58.4 kilos vs. 55.0 kilos squeezed. Average performance of the Placebo Ss on the second day was very stable ranging from 56.5 to 58.4 kilos.

2. Scopolamine induced a significant decrement in performance, dropping the average score from a Baseline Value of 55.0 to a dl value of 48.3 kilos.

3. Recovery was relatively rapid; d4 scores approaching, and d5 scores surpassing Baseline Values.

### Balance

Figure 6 and Table 3 contain the following major findings with respect to performance on the Balance-A test of Gross Body Equilibrium:

1. Undrugged performance of both the Placebo and Scopolamine groups was stable; the Baseline Values for average time balanced were 17.9 secs. for the Placebos and 18.5 secs. for the Scopolamines, respectively.

2. Scopolamine caused a significant drop in balance performance in the drugged group with average balancing time dropping to 5.9 secs., 45 minutes after DA. Performance steadily recovered with subsequent sessions until the drugged group almost returned to its Baseline Value 8 hours and 45 minutes after DA.

3. A slight learning trend was noted for the Placebo group which, at the end of the second day, was averaging close to the maximum value attainable (i.e., 20 secs.).

### Addition

Figure 7 and Table 3 contain the following major findings with respect to performance on the Addition test of Number Facility:

1. Scopolamine Ss averaged slightly higher baseline scores than Placebo Ss; the Baseline Value for mean number of problems correctly solved for the two groups being 41.2 and 36.8 respectively.
2. Scopolamine caused a significant drop in addition score to a d2 session low of only 4.6 problems correctly solved.
3. Recovery was gradual and not complete by the d5 session, at which time the score at 25.7 was still significantly lower than the Baseline.

### Memory Span

Figure 8 and Table 3 show the following major findings with respect to performance on the Auditory Number Span test of Short Term Memory:

1. In baseline testing, a slight but non-significant learning trend was exhibited by both the Placebo and Scopolamine groups, the latter being somewhat better than the former. The Baseline Value for mean number of digits recalled was 6.4 for the Placebo and 7.0 for the Scopolamine groups.
2. Scopolamine caused a significant drop in performance for the drug group reducing the number of digits recalled to a low of 5.1 during the d2 session.
3. Recovery began after the d2 session, but did not quite reach baseline levels by the time of the last test session.

### Time Estimation

Figures 9 and 10 and Table 3 contain the following major findings with respect to performance in Time Estimation:

(Figure 9 presents the average time that was estimated as 10 secs., and Figure 10 presents the variability with which that estimate was made.)

1. The baseline testing demonstrated that both the Placebo and Scopolamine groups were accurately able to estimate the 10 secs. interval, with Baseline Values of 10.40 secs. and 10.44 secs., respectively. Moreover, the variability of the estimate was low with mean variance scores just under .5 secs.

2. The effects of Scopolamine were marked on both the accuracy and variability of the time estimate. Whereas baseline scores in the Scopolamine group tended to fluctuate slightly on both sides of the 10 sec. mark, the average drug scores uniformly showed underestimation, the maximum effect occurring at d1 with an estimate of 8.70 secs.

Simultaneously, while the Placebo Ss maintained their variance scores around .5 secs., the Scopolamine Ss' scores increased markedly to maximum values of 1.6 secs. and 1.3 secs. at the d2 and d3 sessions.

3. By the d5 session, recovery was not complete for the mean scores whose average estimate was 9.53 secs., but it was complete for the variance scores which steadily improved after the d2 session to a near Baseline Value of .54 secs.

#### Reaction Time

Figure 11 and Table 3 contain the following major findings relative to the effects of Scopolamine on Simple Reaction Time to a light stimulus.

1. Baseline Scores for both the Placebo and Scopolamine Groups were very stable ranging from 219 ms. to 235 ms. with a maximum standard deviation of about 30 ms.

2. Scopolamine affected performance markedly, maximally lengthening the time from a Baseline Value of 226 ms. to a d2 value of 396 ms.

3. Recovery was rapid and the average score returned to a better than Baseline level of 211 ms. for the d5 session.

## B. Relative Effectiveness of Scopolamine on Test Performance

One aim of any research effort involving drugs and performance should be the twofold analysis of (a) how severely does a drug affect one kind of performance as opposed to another, and (b) when can the greatest effects of a given drug be expected?

In order to attempt to adequately answer these questions, a technique for comparing performance on differing tests must be found. But the problem is more complicated than it may appear at first insofar as the "common denominator" of the scores cannot be a simple arithmetic difference score, nor can it be a percentile score because differences exist in the kinds of numerical scales on which the scores are based. Thus, for example, while a drop in number of correct addition scores from 40 to 20 may be considered as a 50% loss, a lengthening of Reaction Time from 200 to 400 ms. (equivalent to a doubling or a 100% increase in score value) cannot be interpreted in the same way. In fact, while scores for which lowered values indicate poorer performance have a decrement limit of 100%, scores which indicate poorer performance with increased values (e.g., Visual Acuity; Time Estimate variance) have no such limit to their per cent decrement value.

Thus, short of distorting the scores by using mathematical transforms (e.g., reciprocal values), simple numerical manipulation will not suffice for the comparison of scores on differing numerical scales. The use of the Z-score circumvents many but not all of the problems arising from the use of differing scale systems. It is a measure of the deviation of a test score from its own baseline distribution, providing a common denominator of performance change across tests with respect to each test's scores.

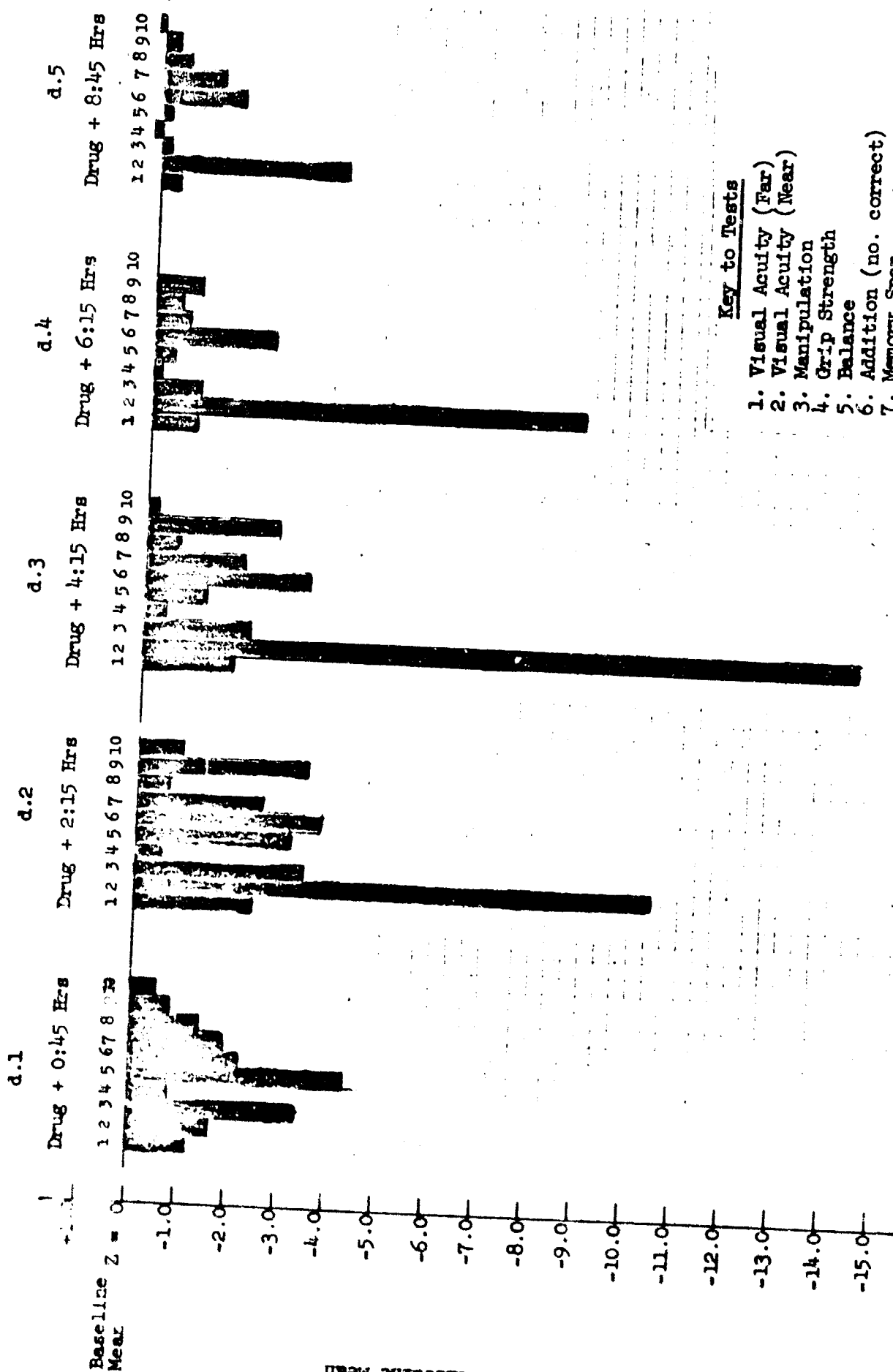
The solution is not perfect inasmuch as the score values themselves are differently distributed in different tests. Since use of Z-score is technically valid only for normally distributed data, its value is limited with score distributions that may be severely truncated (e.g., Balance). Nevertheless, for the present study, the Z-score provides a useful indicator by which performance on most of the different tests may be compared.



TABLE 4

Z-SCORE CHANGE IN PERFORMANCE FROM BASELINE (Z = 0)

Test	Time since drug (hrs.)	0:45 (d1)	2:15 (d2)	4:15 (d3)	6:15 (d4)	8:45 (d5)	Mean
Visual Acuity (Far)	:	-1.12	- 2.31	- 1.73	-0.85	-0.34	-1.27
Visual Acuity (Near)	:	-1.63	-10.34	-14.33	-8.67	-3.65	-7.72
Manipulation	:	-3.31	- 3.33	- 2.10	-0.85	-0.12	-1.94
Grip	:	-0.76	- 0.51	- 0.40	-0.11	+0.23	-0.31
Balance	:	-4.25	- 3.04	- 1.15	-0.34	-0.13	-1.78
Addition (correct)	:	-2.17	- 3.66	- 3.25	-2.39	-1.55	-2.60
Memory	:	-1.77	- 2.41	- 1.90	-0.63	-1.14	-1.57
Time Est. (Mean)	:	-1.30	- 0.58	- 0.64	-0.50	-0.47	-0.70
Time Est. (Variance)	:	-0.74	- 3.37	- 2.53	-0.84	-0.28	-1.55
Reaction Time	:	-0.48	- 0.81	- 0.16	-0.03	+0.07	-0.28
Mean	:	-1.75	- 3.04	- 2.82	-1.52	-0.74	



Key to Tests

1. Visual Acuity (Far)
2. Visual Acuity (Near)
3. Manipulation
4. Grip Strength
5. Balance
6. Addition (no. correct)
7. Memory Span
8. Time Estimation (Mean)
9. Time Estimation (Variance)
10. Reaction Time

Figure 12. Z-Score Comparison of Scopolamine Effects on Performance Tests

Z Score Relative to Baseline Mean

The Z-score, it should be remembered, refers to that point on the distribution of a test's Baseline Value scores equal to the mean score on each drug session; its numerical value is equal to the number of standard deviations away from the Baseline Value.

Table 4 and Figure 12 provide the basic Z-score comparison data.

Three major facts are evident:

- (1) Some tests are far more greatly affected than others, regardless of the time since drug administration.
- (2) In general, the effects of the agent are strongest at the d2 and d3 sessions and recovery is apparent by the d5 session.
- (3) Interactions exist so that for some tests, performance is severely affected by the first session, and recovery is relatively rapid and complete; for other tests, performance continues to drop for several test sessions and recovery is slow and incomplete.

By far, the most dramatic change in performance was on the Visual Acuity (Near) test. Drugged Ss whose average threshold Baseline Values was .95 min. of arc more than trebled their scores to give average thresholds of 3.05 and 3.86 mins. of arc. during peak effects.

In fact, the raw data show that although a few Ss hardly reacted to the drug at all and never exceeded thresholds of 1.5 mins. of arc., other Ss reacted so strongly that they could not read beyond the first target, receiving threshold equivalent scores of 10 mins. of arc. The overall trend was towards serious loss of Near Visual Acuity, and is reflected by Z-score values at the d2 and d3 sessions of -10.34 and -14.33, and by the overall mean value, across sessions, of -7.72.

In contrast, the scores on Grip Strength, Time Estimation (Mean) and Reaction Time all had average Z-scores between 0 and -1.0, reflecting relatively little change as a function of the drug. The averages on the Grip and RT tests, of course, include d5 scores, which surpassed Baseline Values and so produce a somewhat artificially lowered mean score; nevertheless, a glance at the figure shows that these three tests consistently show the least deviation in terms of their Z-scores over most of the test sessions.

One of the clearest trends shown by the Z-score data is the change in test performance over time. The data presented here are basically another way of looking at each test's performance curve as presented in Figs. 2-11, but again, the Z-score permits further comparisons of the performance changes

across tests.

In general, the onset of effects among the tests employed was relatively rapid. Only 45 minutes after Dose Administration, performance dropped to 1.75 standard deviations below Baseline. Performance, in general, continued to worsen and reached a low point where  $Z = -3.04$  at the d2 session, 2 1/4 hours after drug injection. The effects lasted through the d3 session ( $Z = -2.82$ ), and began to lessen by the d4 session until, by the d5 session, 8 3/4 hours after injection, the average Z value was only  $-0.74$ .

Obviously, the table itself shows that these relationships just cited did not hold for all tests; the trends reflected in the Means are general ones and mask some of the idiosyncracies of specific test results. The trends have value in presenting a generalized picture, but careful scrutiny of each test's result is needed to determine what qualifications, if any, are required in applying the trend to each test.

Thus, for example, Near Visual Acuity was poorest at the d3 session and was still severely affected during the last test session. On the other hand, Balance was poorest during the first test session, and in fact, was the most severely affected score for that session.

Similarly, the Time Estimation (Mean) scores were poorest at the d1 session and in general, steadily improved during the course of later sessions.

These exceptions to the general trend are as important as the existence of the trends themselves. When more tests are developed and their reaction to particular chemical agents are studied, it may well be possible to discern test groupings which act differently from other groupings. The sample of tests chosen for this first study was too small to assess such differences but their existence should not be unexpected. Thus, it may be demonstrated that a given agent's effects are primarily on cognitive factors and that factors of physical strength are uninvolved. Or the opposite effect may be engendered by an agent whose effect on neuro-musculature and physical proficiency is relatively great but whose effect on higher mental functioning is negligible.

demonstration of the reality of such effects awaits further testing. These are presented here merely as hypotheses which will be explored as more data are collected in the ongoing research program, involving:

- a) evaluation of the effects of other agents on the tests that have been developed, and
- b) the development of additional performance tests of human abilities.

#### IV. SUMMARY AND CONCLUSIONS

The research effort reported here is the first in a series investigating the effects of incapacitating agents on human performance.

Ten performance tests were selected and developed to represent a diversity of human abilities covering the areas of Sensation-Perception (i.e., Visual Acuity; Time Estimation) Psychomotor Performance (i.e., Reaction Time, Manual Dexterity) Physical Proficiency (i.e., Grip Strength, Balance) and Cognition (i.e., Memory, Addition).

Scopolamine was chosen as a "standard" drug with which the sensitivity of the tests to drug effects was examined at periodic intervals following drug administration.

The results demonstrated the following:

1. The tests selected were sensitive to Scopolamine, which generally led to poorer scores on each of the performances measured.
2. Performance in general was poorest from two to four hours after the drug was administered.
3. Among the abilities studied, Visual Acuity (Near) was most severely affected, while Grip Strength, Reaction Time and the accuracy of Time Estimation were only slightly affected.
4. The general findings cannot be indiscriminately generalized since they do not apply to all tests. For example, 3/4 hours after drug administration, both Manipulation and Balance were more severely affected than Near Visual Acuity. A differential effect is present and the value of using separate ability measures is thereby demonstrated. Drug effects depend at least, in part, on the particular ability tested.

In conclusion, the above results are encouraging for the continued development of the battery.

Test procedures for new tests must be developed, and for existing tests must be modified to meet the special requirements of studying drugged Ss, but the present research has indicated that such procedures are feasible.

It is recognized that the ultimate practical value of the tests will be the extent to which performance changes on the tests can predict performance changes in operational military tasks. Accordingly, once the test battery is developed, and its sensitivity and reliability established,

additional effort must be initially directed towards examining the effects of chemical agents on criterion military tasks and finally, . should be directed towards determining the predictability of such effects from the kind of laboratory-based findings contained in this report.

APPENDIX A

INSTRUCTIONS TO SUBJECTS



STANDARD CHALLENGE

ORIENTATION: Instructions to the Subject

TO START OFF EACH TEST SESSION, I AM GOING TO ROUGHLY DETERMINE YOUR ABILITY TO COOPERATE BY ASKING YOU TO DO THREE SIMPLE THINGS.

I WILL PICK UP ONE OF THESE CARDS (indicate) AND SHOW IT TO YOU. EACH CARD CONTAINS A LETTER FROM A TO Z OR A NUMBER FROM 1 TO 9.

I WILL ASK YOU TO READ THE LETTER OR NUMBER, TAKE THE CARD, AND PLACE IT ON ITS MATCHING SPACE ON THIS BOARD (Indicate the board). ANY QUESTIONS?

FOR EXAMPLE, HERE IS A CARD (select a card and show it to S). WHAT IS IT? (S should read the card) TAKE IT AND PLACE IT IN ITS MATCHING SPACE ON THE BOARD.

(S should follow instructions. Correct any errors that the S makes, and repeat the procedure once more with another card.)

\*\*\*            \*\*\*            \*\*\*            \*\*\*            \*\*\*            \*\*\*            \*\*\*

BASELINE: Instructions to the Subject

AS BEFORE, I'D LIKE YOU TO READ, TAKE, AND MATCH THE CARD SHOWN YOU.  
(Choose a card and show it to the S) WHAT IS IT? (S should read the card)  
TAKE IT AND PLACE IT ON ITS MATCHING SPACE.  
(S should take the card and match it as instructed.)  
( A record should be kept of the standard challenges for each Test Session only during Experimental Testing. Each time an S responds appropriately a check should be placed in the Read, Take or Place column on the Standard Challenge Data Collection Sheet. Inappropriate responses should be indicated by an X.

Note that if a Subject fails to Take a card, he cannot place it; however, he may be able to indicate in some way that he knows the matching square on the board. If he makes such an indication, an X followed by an M in the Place column should be entered.

STANDARD CHALLENGE

EXPERIMENTAL: Instructions to the Subject

PREREQUISITE: The Subjects' eyes must be open to successfully proceed through the battery. If they are not open, get the S to open his eyes. If he does not after two minutes, do not proceed. Throughout each test session, ensure that the S's eyes are open except in those tests (e.g., auditory memory span) where closed eyes do not impair performance.

PLEASE READ, TAKE, AND MATCH THE CARD I SHOW YOU AS YOU DID BEFORE.

(If S appears unresponsive, attempt to get his attention and ask: )

("DO YOU UNDERSTAND ME?" "DO YOU REMEMBER WHAT TO DO?")

Take a card and show it to the S

PLEASE READ THIS CARD (Wait 10 secs. for S's response)

(If no response, ask again; WHAT IS THIS (LETTER, NUMBER)? Point to card)

(Wait 10 secs.)

If no response, mark X in Read Column on the Data Collection Sheet, and hold the card within easy reach of S saying:

NOW TAKE THE CARD (Wait 10 secs. for S's response)

(If no response, say: "COME ON, TAKE THIS CARD THAT I'M HOLDING"

(Wait 10 seconds)

If no response, mark an X in the Take column, and ask the S to point to the matching space on the board saying:

POINT TO THE (LETTER, NUMBER) ON THE BOARD THAT MATCHES THIS CARD. (Wait 10 secs.)

(If no response, say: "COME ON, SHOW ME WHICH OF THESE SQUARES (indicate)

MATCHES THIS CARD I'M HOLDING." (Wait 10 secs.)

(If no response, mark X in the Place column and terminate the test session.)

NOTE: If the S makes the correct responses, follow the procedure indicated for Baseline Testing and Scoring.

VISUAL ACUITY (Far and Near)

ORIENTATION: Instructions for the subject

YOUR FIRST TASK WILL TEST YOUR VISION WITH THIS APPARATUS. IN ALL TESTS WE WOULD LIKE YOU TO LOOK THROUGH THE EYEPiece WHILE RESTING YOUR HEAD ON THIS FOREHEAD REST (indicate).

(Insure that the S is comfortable and adjust the orthorater height, if necessary. Set the Far dial to position #6 and make sure the eyepiece is in the Far position with the left lens covered.)

YOU SHOULD SEE 12 SQUARES OF DIFFERENT SIZES. THREE IN THE TOP ROW, FOUR IN THE MIDDLE AND FIVE IN THE BOTTOM ROW. DO YOU SEE THEM? EACH SQUARE IS CALLED A TARGET.

(Show S the demonstration card and sheet.)

IN EACH TARGET THERE IS A CHECKERBOARD PATTERN IN ONE OF FOUR LOCATIONS, EITHER AT THE TOP (indicate on demonstration card), BOTTOM, RIGHT OR LEFT. THE PATTERN WILL NEVER APPEAR IN THE CENTER.

(Suggest to S that he look in orthorater.)

DO YOU SEE THE CHECKERBOARD PATTERNS? EACH TIME YOU ARE TESTED I WILL ASK YOU TO TELL ME THE POSITION OF THE LARGEST TARGET. JUST ANSWER EITHER TOP RIGHT, TOP LEFT, BOTTOM LEFT OR BOTTOM RIGHT. THEN I WILL ASK YOU WHERE THE CHECKERBOARD PATTERN IS. JUST SAY TOP, BOTTOM, RIGHT OR LEFT. THEN I WILL SAY "NEXT" AND YOU WILL TELL ME THE POSITION OF THE CHECKERBOARD IN THE NEXT SMALLER TARGET. REMEMBER, ALWAYS READ FROM THE LARGEST TO THE SMALLEST TARGET.

(Indicate to S on the demonstration sheet the pattern he is to read.)

AND WAIT TILL I SAY "NEXT" BEFORE GOING TO THE NEXT SMALLER TARGET. WHEN THE PATTERN GETS HARDER TO SEE, YOU MAY GUESS, BUT ONLY IF YOU HAVE SOME IDEA OF WHERE THE CHECKERBOARD PATTERN IS. DON'T MAKE A WILD GUESS IF YOU HAVE NO IDEA AT ALL.

(Make sure the far dial is set at #6)

OK, NOW TELL ME WHERE THE LARGEST TARGET IS. (S should say TOP LEFT.

(Correct any mistakes in procedure.) (Have the S read as far as he can, reminding him to wait till you say NEXT before reading the next smaller target.)

The correct response to plate #6 are B R L

B L R L

L R T R T

REMEMBER, ON THIS PLATE THE LARGEST TARGET WAS ON THE TOP LEFT OF THE PLATE BUT THIS WILL NOT ALWAYS BE TRUE. SOMETIMES YOU'LL BE STARTING AT THE

VISUAL ACUITY (Far and Near)

TOP RIGHT OR BOTTOM RIGHT OR BOTTOM LEFT ON A PLATE. BUT, WHEREVER THE POSITION OF THE LARGEST TARGET, ALWAYS START WITH IT WHEN YOU READ. ARE THERE ANY QUESTIONS?

(Always follow the sequence of plates indicated by the numbers in parentheses on the Data Collection Sheet. Don't forget to change the position of the eyepiece from near to far each time and to turn over the answer sheet.)

(Turn to the first plate indicated on response sheet.)

OK, WHERE IS THE LARGEST TARGET? (S responds correctly.) AND WHERE IS THE CHECKERBOARD? (S responds correctly.) NEXT, etc., etc., etc.

(Continue the test trial until the S makes an error. Conduct the second Far Acuity trial using the same procedures. Then, conduct the two Near Acuity trials, always asking for target location before each set of acuity readings.)

VISUAL ACUITY (Far and Near)

BASELINE: Instructions for the subject

DON'T FORGET TO READ THE POSITIONS OF THE CHECKBOARDS ALWAYS GOING FROM THE LARGEST TO THE SMALLEST TARGET. DO NOT GUESS IF YOU CANNOT SEE ANY DIFFERENCE AT ALL IN THE SQUARES IN THE TARGET. WAIT FOR ME TO SAY "NEXT" BEFORE MAKING THE NEXT RESPONSE.

(When S comes to the threshold targets, remind him that he should guess only if he can detect some difference in the squares.)

EXPERIMENTAL: Instructions for the subject

DO YOU REMEMBER HOW TO TAKE THIS TEST? REMEMBER---FIRST TELL ME THE POSITION OF THE LARGEST TARGET, THEN SAY WHETHER THE CHECKERBOARD IS RIGHT, LEFT, TOP OR BOTTOM. ALWAYS GO FROM THE LARGEST TO THE SMALLEST SQUARE ACROSS EACH ROW. DON'T FORGET TO WAIT UNTIL I SAY "NEXT" BEFORE CONTINUING.

NOW, WHERE IS THE LARGEST TARGET?

(If S does not respond, repeat up to three times within a one-minute period. If there is still no response, ask:)

WHAT IS THE POSITION OF THE FIRST CHECKERBOARD?

(Ask S to point position if he has difficulty speaking.

If S still does not respond after three such attempts within a one minute period, terminate and go on to the next test.)

MINNESOTA (Displacing)

ORIENTATION: Instructions for the subject

THE OBJECT OF THIS TEST IS TO SEE HOW FAST YOU CAN MOVE THE BLOCKS INTO THE VACANT HOLE.

THIS IS THE WAY YOU DO THE TEST: (Move the blocks while saying the following:) FILL THE TOP HOLE WITH THE BLOCK BELOW IT, THE NEXT EMPTY HOLE WITH THE BLOCK JUST BELOW, AND KEEP ON DOING THIS UNTIL THE BOTTOM HOLE IN THE FIRST COLUMN IS EMPTY. NOW FILL THE BOTTOM HOLE WITH THE BOTTOM BLOCK IN THE SECOND COLUMN. IN THIS COLUMN KEEP FILLING EACH EMPTY HOLE WITH THE BLOCK ABOVE IT, UNTIL THE TOP HOLE IS EMPTY. CONTINUE MOVING THE BLOCKS IN THIS WAY UNTIL YOU ARE TOLD TO STOP. YOU WILL HAVE 30 SECONDS IN WHICH TO MOVE AS MANY BLOCKS AS YOU CAN.

YOU MAY USE EITHER HAND, BUT YOU MUST USE THE HAND YOU CHOOSE THROUGHOUT THE TESTS. WHICH HAND WOULD YOU PREFER TO USE? (record in the upper-right hand corner of the data collection sheet).

USE YOUR FREE HAND TO STEADY THE BOARD. BE SURE THAT THE BLOCKS ARE ALL THE WAY DOWN. IF ANY BLOCKS DROP, DO NOT STOP TO PICK THEM UP, BUT CONTINUE FILLING THE HOLES. (Put the blocks into the starting position).

LET'S TRY A PRACTICE TRIAL. WHEN I SAY "READY" PUT YOUR (RIGHT, LEFT) HAND ON THE FIRST BLOCK YOU'RE GOING TO MOVE.

READY?

GO!

(Allow the subject to move 12 blocks. Watch the subject to be sure he is doing the test properly. Give any help needed on the practice trial).

-----PRACTICE----- (12 blocks)

STOP AND TAKE A SHORT REST PERIOD

-----REST----- (15 seconds)

(Reset blocks)

NOW LET'S START THE FIRST TRIAL. ARE YOU READY?

GO!

-----TEST----- (30 seconds)

STOP!

YOU WILL NOW HAVE A SHORT REST PERIOD

-----REST----- (15 seconds)

(Reset blocks)

NOW GET SET FOR THE SECOND TRIAL. ARE YOU READY?

GO!

-----TEST----- (30 seconds)

STOP!

MINNESOTA (Displacing)

BASELINE: Instructions for the subject

(Before each baseline test say to the subject:)

DON'T FORGET - WHEN I SAY "READY" PUT YOUR (RIGHT, LEFT) HAND ON  
THE FIRST BLOCK YOU ARE GOING TO MOVE. WHEN I SAY "GO" START FILLING THE EMPTY  
HOLES.

WE'LL NOW HAVE A PRACTICE TRIAL

READY?

GO!

-----PRACTICE-----

Stop the S after  
he has correctly moved  
(12 blocks)

(Reset the blocks)

NOW WE'LL START THE FIRST TRIAL.

READY?

GO!

-----TEST-----

(30 seconds)

YOU WILL NOW HAVE A SHORT REST PERIOD

-----REST-----

(15 seconds)

(Reset the blocks)

NOW GET SET FOR THE NEXT TRIAL

READY?

GO!

-----TEST-----

(30 seconds)

THAT IS THE END OF THE TEST.

MINNESOTA (Displacing)

EXPERIMENTAL: Instructions for the subject

(Before each experimental test ask the subject:)

DO YOU REMEMBER WHAT YOU ARE SUPPOSED TO DO?

DON'T FORGET - WHEN I SAY "READY" PUT YOUR (RIGHT, LEFT) HAND ON THE FIRST BLOCK YOU'RE GOING TO MOVE. WHEN I SAY "GO" START FILLING THE EMPTY HOLES.

WE'LL NOW HAVE A PRACTICE TRIAL

READY?

(If the S does not get "READY" repeat up to 3 times in one minute: "PUT YOUR HAND ON THE BLOCK." If necessary, place his hand on the block.)

GO!

(If the S does not respond, repeat a maximum of 3 times in one minute: "MOVE THE BLOCK INTO THE HOLE." If the S still does not respond, he will be considered untestable. Go to the next apparatus.)

-----PRACTICE----- (12 blocks)

NOW WE'LL START

READY? (same as above)

GO! (same as above)

-----TEST----- (30 seconds)

YOU WILL NOW HAVE A SHORT REST PERIOD

-----REST----- (15 seconds)

NOW GET SET FOR THE NEXT TRIAL

READY? (same as above)

GO! (same as above)

-----TEST----- (30 seconds)

THAT IS THE END OF THE TEST.



HAND GRIP

ORIENTATION: Instructions for the subject

(Prior to each test, ensure that the pointer is set at zero.)

THE NEXT TEST WILL MEASURE YOUR GRIP STRENGTH. YOUR TASK WILL BE TO SQUEEZE THIS HAND GRIP AS HARD AS YOU CAN. (indicate grip).

YOU MAY USE EITHER HAND, BUT YOU MUST USE THE SAME HAND IN ALL TEST SESSIONS. WHICH HAND WOULD YOU PREFER? (record).

YOU WILL STAND ALONG SIDE OF THE HAND GRIP AND SQUEEZE WITH YOUR LEFT, RIGHT) HAND LIKE THIS (demonstrate position and squeeze). (reset).

WHEN I SAY "READY" STAND BY THE HAND GRIP AND PLACE YOUR HAND ON IT. DO NOT SQUEEZE UNTIL I SAY GO. ONLY SQUEEZE ONCE, AS HARD AND AS STEADILY AS YOU CAN. DO NOT LIFT OR PUSH THE GRIP; JUST SQUEEZE IT ONCE FOR ABOUT A SECOND AND THEN RELEASE IT. LET'S TRY A PRACTICE TRIAL. ANY QUESTIONS?

READY?

GO!

(Watch the subject to be sure that he is responding properly. Give any help needed on the practice trial.)

-----TRIAL----- (1 squeeze)

STOP!

YOU WILL NOW HAVE A SHORT REST PERIOD.

-----REST----- (1 minute)

NOW LET'S START THE FIRST TRIAL.

READY?

GO!

-----TRIAL----- (1 squeeze)

STOP!

YOU WILL NOW HAVE ANOTHER REST PERIOD.

-----REST----- (1 minute)

NOW GET SET FOR THE NEXT TRIAL.

READY?

GO!

-----SQUEEZE----- (1 squeeze)

STOP!

HAND GRIP

BASELINE: Instructions for the subject

(Before each baseline test say to the S:)

DON'T FORGET - WHEN I SAY "READY," GET READY TO SQUEEZE; WHEN I SAY "GO" SQUEEZE ONCE, AS HARD AND AS STEADILY AS YOU CAN. REMEMBER TO USE YOUR (RIGHT, LEFT) HAND.

DO YOU HAVE ANY QUESTIONS?

READY?

GO!

-----TRIAL----- (1 squeeze)

YOU WILL NOW HAVE A SHORT REST PERIOD.

-----REST----- (1 minute)

NOW GET SET FOR THE NEXT TRIAL.

READY?

GO!

-----TRIAL----- (1 squeeze)

THAT IS THE END OF THE TEST.

HAND GRIP

EXPERIMENTAL: instructions for the subject

(Before each experimental test ask the subject:)

DO YOU REMEMBER WHAT YOU WERE SUPPOSED TO DO?

DOCN'T FORGET - WHEN I SAY "READY," GET READY TO SQUEEZE: WHEN I SAY "GO" SQUEEZE ONCE, AS HARD AND AS STEADILY AS YOU CAN. REMEMBER TO USE YOUR (RIGHT, LEFT) HAND.

DO YOU HAVE ANY QUESTIONS?

READY?

(If the subject does not get "ready", put him into position and say, "NOW COME ON, PUT YOUR HAND ON THE GRIP." Repeat a maximum of 3 times in one minute.)

GO!

(If he does not squeeze, repeat, "NOW SQUEEZE AS HARD AS YOU CAN." You may also repeat this no more than 3 times in one minute. If the subject still does not respond, he will be considered untestable. Go to the next apparatus.)

-----TRIAL----- (1 squeeze)

YOU WILL NOW HAVE A SHORT REST PERIOD.

-----REST----- (1 minute)

NOW GET SET FOR THE NEXT TRIAL.

READY?

(same as above)

GO?

(same as above)

-----TRIAL----- (1 squeeze)

THAT IS THE END OF THE TEST.

BALANCE TEST

ORIENTATION: Instructions for the subject

YOUR TASK WILL BE TO BALANCE YOURSELF ON THIS RAIL (point to rail) USING ONLY ONE FOOT. YOU MAY USE EITHER FOOT, BUT YOU MUST USE THE SAME FOOT THROUGHOUT THE TESTS. WHICH FOOT WOULD YOU PREFER? (record).

YOU WILL PLACE YOUR (RIGHT, LEFT) FOOT LENGTHWISE ON THE RAIL. (Demonstrate) YOUR SCORE WILL BE THE AMOUNT OF TIME YOU BALANCE ON THE RAIL WITHOUT TOUCHING THE FLOOR OR THE PLATFORM. WHEN I SAY "READY" PLACE YOUR FOOT ON THE RAIL. WHEN I SAY "GO," LIFT YOUR OTHER FOOT AND BALANCE. TRY TO BALANCE UP TO 20 SECONDS. THE SCORING WILL START AS SOON AS YOU LIFT YOUR OTHER FOOT. THE SCORING WILL STOP EITHER WHEN YOU TOUCH THE FLOOR OR THE PLATFORM, OR WHEN 20 SECONDS IS UP. LET'S TRY A PRACTICE TRIAL.\*

DO YOU HAVE ANY QUESTIONS?  
(answer all questions)

READY?  
GO!

-----PRACTICE----- (10 seconds)  
(Watch the subject to be sure he is doing the test properly. Give any help needed on the practice trial.)

STOP! YOU WILL NOW HAVE A SHORT REST PERIOD.  
-----REST----- (10 seconds)

NOW LET'S START THE FIRST TRIAL. ARE YOU READY?  
READY?  
GO!  
-----TRIAL----- (20 seconds)

STOP! YOU WILL NOW HAVE ANOTHER REST PERIOD.  
-----REST----- (10 seconds)

NOW GET SET FOR THE NEXT TRIAL. ARE YOU READY?  
READY?  
GO!  
-----TRIAL----- (20 seconds)

STOP!

NOTE: If at any time an S balances for less than 5 secs., do not record a score, but let him try immediately to balance again. A total of 3 tries should be permitted. If S fails three times to balance for at least 5 secs., record a zero.

BALANCE TEST

BASELINE: Instructions for the subject

DON'T FORGET -- WHEN I SAY "READY," PUT YOUR (RIGHT, LEFT) FOOT ON THE  
RAIL. WHEN I SAY "GO," YOU WILL BALANCE AND THE SCORING WILL START.  
DO YOU HAVE ANY QUESTIONS?

WE'LL NOW HAVE A SHORT PRACTICE.

READY?

GO!

-----PRACTICE----- (10 seconds)

STOP!

WE'LL NOW START THE FIRST TRIAL.

READY?

GO!

-----TRIAL----- (20 seconds)

STOP!

YOU WILL NOW HAVE A SHORT REST PERIOD.

-----REST----- (10 seconds)

NOW GET SET FOR THE NEXT TRIAL.

READY?

GO!

-----TRIAL----- (20 seconds)

STOP!

BALANCE TEST

EXPERIMENTAL: Instructions for the subject

DO YOU REMEMBER WHAT YOU ARE SUPPOSED TO DO?  
DON'T FORGET -- WHEN I SAY "READY," PUT YOUR (RIGHT, LEFT) FOOT ON  
RAIL. WHEN I SAY "GO," YOU WILL BALANCE AND THE SCORE WILL START.

DO YOU HAVE ANY QUESTIONS?  
WE'LL NOW HAVE A SHORT PRACTICE.

READY?  
(If he does not get set, put him into position and  
say: "NOW COME ON, PUT YOUR FOOT ON THE RAIL". Repeat  
a maximum of 3 times in 1 minute.)

GO!  
(If he does not start, say:  
"NOW LIFT YOUR OTHER FOOT AND BALANCE:" Repeat in 1 min., a  
maximum of 3 times. If the subject still does  
not respond, he will be considered untestable.  
Go to the next apparatus.)

-----PRACTICE----- (10 seconds)

STOP!  
WE'LL NOW START THE FIRST TRIAL.

READY? (same as above)

GO! (same as above)

-----TRIAL----- (20 seconds)

STOP!  
WE'LL NOW HAVE A SHORT REST PERIOD.

-----REST----- (10 seconds)

NOW GET SET FOR THE NEXT TRIAL.

READY? (same as above)

GO! (same as above)

-----TRIAL----- (20 seconds)

STOP!

ADDITION

ORIENTATION: instructions for the subject

THIS IS A TEST OF HOW WELL YOU CAN ADD NUMBERS. THIS SHOWS YOU WHAT THE PROBLEMS WILL LOOK LIKE (show S the practice problem). THE FIRST PROBLEM HAS BEEN WORKED CORRECTLY. NOTICE THAT THE ANSWER TO THE PROBLEM IS PLACED IN THE BOX BELOW THE PROBLEM. PLEASE WORK THE SECOND PROBLEM AND PUT THE ANSWER IN THE BOX BELOW IT.

DO YOU HAVE ANY QUESTIONS BEFORE YOU BEGIN?  
OK, YOU MAY BEGIN.

(After the subject has solved the practice problem and you have corrected any procedural errors, give him the test sheet containing ninety problems, and read him the following instructions:)

YOU WILL BE GIVEN THREE MINUTES IN WHICH TO SOLVE AS MANY OF THESE PROBLEMS AS POSSIBLE. DON'T SKIP ANY PROBLEMS. WORK THEM FROM LEFT TO RIGHT STARTING ON THE TOP LINE. WORK AS QUICKLY AS YOU CAN BUT ALSO TRY TO BE AS ACCURATE AS YOU CAN. I WILL TELL YOU WHEN THREE MINUTES ARE UP.  
ANY QUESTIONS?

READY?

GO!

(Watch the subject to be sure that he is responding properly. Give any help needed on the practice trial.)

-----TEST-----

(3 minutes)

STOP!

THAT IS THE END OF THE TEST.

ADDITION

BASELINE: Instructions for the subject

DON'T FORGET - WHEN I SAY "GET READY," PREPARE TO ADD THE PRACTICE PROBLEM. WHEN I SAY "GO," START TO ADD. KEEP WORKING UNTIL I SAY "STOP." WE'LL NOW HAVE A PRACTICE PROBLEM. DO YOU HAVE ANY QUESTIONS?

READY?

GO!

-----PRACTICE-----

(1 problem)

OK, NOW WE'LL START THE TEST.

READY?

GO!

-----TEST-----

(3 minutes)

STOP!

THAT IS THE END OF THE TEST.



ADDITION

EXPERIMENTAL: Instructions for the subject

DO YOU REMEMBER WHAT YOU ARE SUPPOSED TO DO?

DON'T FORGET - WHEN I SAY "READY," PREPARE TO ADD THE FIRST PROBLEM.

WHEN I SAY "GO," START TO ADD. KEEP WORKING UNTIL I SAY "STOP." WE'LL  
START WITH A PRACTICE PROBLEM. ANY QUESTIONS?

READY?

(If the S does not get "READY" repeat a maximum of 3 times in  
1 min.: "HOLD THE PENCIL AND GET READY TO ADD THE  
PROBLEMS." If necessary, place the pencil in his hand.)

GO!

(If the S does not respond, repeat a maximum of 3 times in 1 min.:  
"START ADDING." If the S still does not respond, he will  
be considered untestable. Go to the next apparatus.)

-----PRACTICE----- (1 problem)

OK, NOW WE'LL START THE TEST.

READY? (same as above)

GO! (same as above)

-----TEST----- (3 minutes)

STOP!

THAT IS THE END OF THE TEST.

MEMORY

ORIENTATION: Instructions for the subject

THIS IS A TEST OF HOW WELL YOU REMEMBER NUMBERS. WHEN I START THE TAPE RECORDER, YOU WILL HEAR THE WORD "READY," FOLLOWED BY A GROUP OF NUMBERS. LISTEN CAREFULLY TO THESE NUMBERS BECAUSE YOU MUST REPEAT THEM TO ME IMMEDIATELY IN THE SAME ORDER THAT YOU HEARD THEM. DON'T WAIT FOR ME TO ASK YOU TO REPEAT THEM. FIRST, LET'S TRY A PRACTICE RUN. YOU WILL HEAR THE WORD "READY," FOLLOWED BY THREE NUMBERS. I WANT YOU TO REPEAT THEM BACK TO ME.

(Press the start key of the tape recorder. When the three numbers have been presented, stop the tape recorder immediately. Listen for the response of the subject and compare his response with the digits listed on the master sheet of correct digits. If the subject is wrong, try to determine whether he misunderstood the instructions and give all the help needed.)

DURING THE TEST PERIOD, YOU'LL FIRST BE ASKED TO REPEAT A GROUP OF THREE NUMBERS. YOU'LL HAVE 15 SECONDS TO ANSWER. REMEMBER TO REPEAT THE NUMBERS BACK IMMEDIATELY. AT THE END OF 15 SECONDS, YOU'LL AGAIN HEAR "READY," FOLLOWED BY A SECOND GROUP OF THREE NUMBERS, AND AGAIN, YOU'LL HAVE 15 SECONDS TO REPEAT THEM. WHEN YOU'VE FINISHED THE TWO GROUPS OF THREE NUMBERS, YOU'LL BE GIVEN TWO GROUPS OF FOUR NUMBERS, THEN TWO GROUPS OF FIVE NUMBERS, AND SO ON. EVEN IF YOU THINK YOU CAN'T REMEMBER THE NUMBERS, TRY TO GUESS THEM. ANY QUESTIONS?

(Answer the subject's questions here if he has any.)

OK. LET'S BEGIN.

(Press the start key on the tape recorder.)

-----TRIAL-----

(At each level tested, record a + for every correct response and a - for every incorrect response. Continue testing until the S misses two number groups at a given level. Record as the score the highest level on which at least one correct response was made.)

MEMORY

BASELINE: Instructions for the subject

(Before each baseline test, ensure that the tape is set at the right place at the start of each test session)

DON'T FORGET, REPEAT THE NUMBERS YOU HEAR IMMEDIATELY. DON'T WAIT FOR ME TO ASK YOU TO REPEAT THEM.

OK. LET'S BEGIN THE TEST.

(Press the start key of the tape recorder; score as indicated on the Orientation page).

MEMORY

EXPERIMENTAL: Instructions for the subject

DO YOU REMEMBER WHAT YOU ARE SUPPOSED TO DO?

DON'T FORGET, REPEAT THE NUMBERS IMMEDIATELY - DO NOT WAIT FOR ME  
TO REPEAT THEM.

OK, LET'S BEGIN THE TEST.

(If the S does not respond in the 15 sec. interval, stop  
the recorder before the next set of numbers is presented,  
and say to S: "REPEAT THE NUMBERS YOU JUST HEARD." If  
no response,

- a) ensure that the S is paying attention
- b) return the tape to the set of numbers  
just presented
- c) say: "NOW REPEAT THE NUMBERS YOU HEAR"
- d) replay the numbers and wait 15 secs.  
for a response.

If no response say: "COME ON NOW, REPEAT THE NUMBERS YOU  
JUST HEARD."

If no response in 15 secs., terminate the Memory Test and  
proceed to the next test).

TIME ESTIMATION

ORIENTATION: Instructions for the subject

(Prior to each test, ensure that the equipment is operating correctly, AND that the switch is in the OFF position. The first time the S comes in, read him the following:)

THIS IS A TEST TO MEASURE YOUR ABILITY TO ESTIMATE A TIME PERIOD OF 10 SECONDS. EACH TIME YOU MAKE AN ESTIMATE, YOU MUST THROW THIS SWITCH FROM THE "OFF" TO THE "ON" POSITION LIKE THIS: (demonstrate by throwing the switch ON) THEN, YOU SHOULD COUNT SILENTLY TO YOURSELF FROM 1 TO 10, AT A RATE THAT YOU FEEL IS ONE COUNT PER SECOND. WHEN YOU HAVE COUNTED TO 10, RETURN THE SWITCH TO THE OFF POSITION LIKE THIS: (demonstrate by throwing the switch OFF) THE ACTUAL TIME IS RECORDED ON THIS CLOCK HERE (indicate the clock). DURING THIS SESSION, I WILL TELL YOU WHAT YOUR ACTUAL TIME WAS SO THAT YOU CAN "SET" YOURSELF TO COUNT AS CLOSE TO 10 SECONDS AS POSSIBLE. LATER ON IN THE EXPERIMENT, YOU WON'T BE TOLD HOW GOOD YOUR ESTIMATES WERE, BUT YOU CAN FIND THIS OUT AFTER THE STUDY IS OVER.

I'D LIKE YOU TO TRY AN ESTIMATE NOW. ALWAYS WAIT UNTIL I SAY "GO" BEFORE THROWING THE SWITCH TO ON. THEN COUNT TO YOURSELF FROM 1 TO 10 AND SWITCH TO OFF. DO YOU HAVE ANY QUESTIONS?

(Answer all questions to ensure that the S understands and can follow the instructions.)

WE'LL NOW HAVE A PRACTICE TRIAL. I WILL SAY "READY" EACH TIME BEFORE

DO YOU HAVE ANY QUESTIONS?

OK, READY?

GO!

(Watch the subject to be sure that he is responding properly. Give any help needed on the practice trial.)

-----PRACTICE----- (1 estimation)

FINE! YOUR ESTIMATION WAS \_\_\_\_\_.

NOW WE'LL HAVE 10 TRIALS IN A ROW.

READY?

GO!

YOUR ESTIMATION WAS \_\_\_\_\_.

(Repeat this procedure for 10 estimates)

BASELINE: Instructions for the subject

(Before each baseline test ask the subject:)

DON'T FORGET - I WILL SAY "READY" BEFORE EACH TRIAL AND I WILL SAY "GO" WHEN YOU ARE TO START. REMEMBER TO COUNT TO YOURSELF FROM 1 TO 10 THEN THROW THE SWITCH OFF. ALL ESTIMATIONS WILL BE FOR 10 SECONDS.

DO YOU HAVE ANY QUESTIONS?

OK, NOW WE'LL START THE FIRST TRIAL.

READY?

GO!

-----TEST----- (5 estimations)

(Repeat this procedure for 5 estimations. Do not tell the S his score.)

TIME ESTIMATION

EXPERIMENTAL: Instructions for the subject

(Before each experimental test ask the subject:)

DO YOU REMEMBER WHAT YOU ARE SUPPOSED TO DO?

DON'T FORGET - I WILL SAY "READY" BEFORE EACH TRIAL AND I WILL SAY "GO" WHEN YOU ARE TO START. REMEMBER TO COUNT TO YOURSELF FROM 1 TO 10 THEN THROW THE SWITCH OFF. ALL ESTIMATIONS WILL BE FOR 10 SECONDS.

DO YOU HAVE ANY QUESTIONS?

OK, NOW WE'LL START THE FIRST TRIAL.

READY?

(If the S does not get "READY" repeat a maximum of 3 times in 1 min.: "PUT YOUR HAND ON THE SWITCH." If necessary, place his hand on the switch).

GO!

(If the S does not respond, repeat a maximum of 3 times in 1 min.: "THROW THE SWITCH AND COUNT TO TEN." If the S still does not respond, he will be considered untestable. Go to the next apparatus).

-----TEST----- ( 5 estimations)

(Repeat this procedure for 5 estimations. Do not tell the S his score.)

SIMPLE REACTION TIME

ORIENTATION: Instructions for the subject

THIS IS A TEST TO SEE HOW FAST YOU CAN REACT TO A LIGHT. YOUR TASK WILL BE TO PRESS THIS BUTTON (point) WITH YOUR INDEX FINGER AS FAST AS YOU CAN WHEN THE LIGHT COMES ON. YOU MAY USE EITHER HAND. WHICH HAND WOULD YOU PREFER? (record) WHEN I SAY "READY," ALWAYS KEEP YOUR FINGER LIGHTLY ON THE BUTTON. WHEN I SAY "GO," WAIT FOR THE LIGHT AND PRESS THE BUTTON AS SOON AS IT APPEARS. NEVER HOLD THE BUTTON PRESSED DOWN. ALWAYS WAIT FOR THE LIGHT BEFORE PRESSING THE BUTTON. IF YOU "JUMP THE GUN" BEFORE THE LIGHT, AN ERROR WILL BE COUNTED AGAINST YOU.

NOW WE'LL TRY A FEW PRACTICE TRIALS.

(Ensure that switch is on Demo\*, that the Control Box switch is OFF and that the Remote jack is plugged in)

READY?

GO! (Press the button for each stimulus)

(Watch the subject to be sure that he is responding properly. Give any help needed on the practice trial.)

-----PRACTICE-----

(4 demonstrations)

OK, YOU'LL NOW HAVE A SHORT REST PERIOD

-----REST-----

(30 seconds)

(Record clock and counter readings)

NOW LET'S START THE FIRST TRIAL.

READY?

(Throw switch to Test. Green light should appear on Control Box.)

GO! (Press button long enough for Green light on Control Box to go off)

-----TRIAL-----

(10 stimuli)

OK, YOU'LL NOW HAVE ANOTHER REST PERIOD.

-----REST-----

(30 seconds)

(Green light comes back on after 10 stimuli have been presented. Read and record the clock and counters during the rest period.)

NOW GET SET FOR THE NEXT TRIAL.

READY?

GO! (Press button)



SIMPLE REACTION TIME

ORIENTATION: Instructions for the subject (Continued)

-----TRIAL-----

(10 stimuli)

(record clock and counter readings)

(Always return the switch to Demo position and reset the clock and counters to be ready for the next session).

\* Note that throwing the switch from Test to Demo, will act like a Demo presentation.

SIMPLE REACTION TIME

BASELINE: Instructions for the subject

(Before each baseline test, ensure that switch is in Demo position.)

DON'T FORGET - WHEN I SAY "READY" PUT YOUR (RIGHT, LEFT) INDEX FINGER ON THE BUTTON. WHEN I SAY "GO," WAIT FOR THE LIGHT AND PRESS THE BUTTON AS SOON AS IT APPEARS.

WE'LL NOW HAVE TWO PRACTICE TRIALS. (Control switch should be on Demo)

READY? GO! (Press button for each stimulus)

-----PRACTICE----- (2 stimuli)

(Read the clock and counter readings)

NOW WE'LL START THE FIRST TRIAL

(Throw switch to Test)

READY? GO! (Press button)

-----TEST----- (10 stimuli)

YOU'LL NOW HAVE A SHORT REST PERIOD.

-----REST----- (30 seconds)

(Record the clock and counter readings)

NOW GET SET FOR THE NEXT TRIAL.

READY? GO! (Press button)

-----TEST----- (10 stimuli)

(Record clock and counters)

THAT IS THE END OF THE TEST.

SIMPLE REACTION TIME

EXPERIMENTAL: Instructions for the subject

(Before each experimental test ask the subject:)

DO YOU REMEMBER WHAT YOU ARE SUPPOSED TO DO?

DON'T FORGET - WHEN I SAY "READY," PUT YOUR (RIGHT, LEFT) INDEX FINGER ON THE BUTTON. WHEN I SAY "GO," WAIT FOR THE LIGHT AND PRESS THE BUTTON AS SOON AS IT APPEARS.

WE'LL NOW HAVE TWO PRACTICE TRIALS.

DO YOU HAVE ANY QUESTIONS?

READY?

(Ensure that the control switch is on Demo)

(If the S does not get "READY" repeat in 1 min. up to 3 times: "NOW PUT YOUR FINGER ON THE BUTTON." If necessary, place his finger on the button.)

GO! (Press control button)

(If the S does not respond, repeat a maximum of 3 times in 1 min.: "NOW PUSH THE BUTTON." If the S still does not respond, he will be considered untestable. Go to the next apparatus.)

-----PRACTICE----- (2 demonstrations)

NOW WE'LL START

READY?

(Throw control switch to Test)

(If the S does not get "READY" repeat in 1 min. up to 3 times: "NOW PUT YOUR FINGER ON THE BUTTON." If necessary, place his finger on the button.)

GO! (Press control button)

(If S does not respond, he will be considered untestable. Go to the next apparatus.)

-----TEST----- (10 stimuli)

YOU WILL NOW HAVE A SHORT REST PERIOD

-----REST----- (30 seconds)

NOW GET SET FOR THE NEXT TRIAL.

READY? (same as above)

GO! (same as above)

-----TEST----- (10 stimuli)

THAT IS THE END OF THE TEST.

APPENDIX B

METHODOLOGICAL CONSIDERATIONS

TABLE 5  
SUBJECT DATA

Trtmnt.	S	Init.	Rank	D. O. B. *	H. G. C. *	Specialty
P L A C E B O	1	JR	Pfc	5/27/40	15	Corpsman
	2	ER	Pfc	2/ 7/45	12	Eng. Equip. Repairman
	3	JC	Sp/4	11/10/39	12	Lt. Veh. Driver
	4	DP	Pfc	3/ 5/42	12	Field Artillery
S C O P O L A M I N E	5	RN	Pfc	1/ 9/44	11	Supply Handler
	6	RM	Sp/4	2/17/42	12	Infantry Man
	7	TB	Pfc	6/ 2/42	13	Clinical Psychol. Spec.
	8	ND	Pvt.	12/12/42	14	Clerk
	9	RH	Sgt.	11/ 1/38	12	Armor Crewman
	10	BR	Sp/5	7/17/44	12	Helicopter Mech.
	11	BS	Pfc	7/22/42	14	Clerk Typist
	12	RW	Pfc	9/ 5/43	11	Corpsman
	13	BK	Pfc	3/ 3/45	12	Construction Mech.
	14	JN	Pfc	1/31/44	12	Clerk Typist
	15	HS	Sp/4	9/27/44	12	Infantry Crewman

\*D. O. B. - Date of Birth

\*H. G. C. - Highest Grade Completed

Table 6 Four-Subject Test Schedule

<u>1st Day</u>	<u>Time</u>	<u>2nd Day</u>	<u>Time</u>	<u>2nd Day</u>	<u>Time</u>
O	0830-0945 0900-1015 0930-1045 1000-1115	b. 5	0830-0915 0845-0930 0900-0945 0915-1000	d. 4	1530-1615 1545-1630 1600-1645 1615-1700
R	0945-1100 1015-1115 1045-1130 1115-1145	DA	0915-0930 0930-0945 0945-1000 1000-1015	R&M	1615-1800 1630-1815 1645-1830 1700-1845
b. 1	1100-1145 1115-1200 1130-1215 1145-1230	R	0930-1000 0945-1015 1000-1030 1015-1045	d. 5	1800-1845 1815-1900 1830-1915 1845-1930
M	1145-1230 1200-1245 1215-1300 1230-1315	d. 1	1000-1045 1015-1100 1030-1115 1045-1130		
b. 2	1230-1315 1245-1330 1300-1345 1315-1400	M	1045-1130 1100-1145 1115-1200 1130-1215		
R	1315-1400 1330-1415 1345-1430 1400-1445	d. 2	1130-1215 1145-1230 1200-1245 1215-1300		
b. 3	1400-1445 1415-1500 1430-1515 1445-1530	R	1215-1330 1230-1345 1245-1400 1215-1300		
R	1445-1530 1500-1545 1515-1600 1530-1615	d. 3	1330-1415 1345-1430 1400-1445 1415-1500		
b. 4	1530-1615 1545-1630 1600-1645 1615-1700	R	1415-1530 1430-1545 1445-1600 1500-1615		

Key

- O = Orientation
- R = Rest
- M = Mealtime
- b = Baseline Test Session
- DA = Dose Administration
- d = Dosage Test Session

APPENDIX C

SIGNIFICANCE TESTS

TABLE 7

SIGNIFICANCE OF PERFORMANCE DIFFERENCES IN DRUGGED Ss' BASELINE AND DRUG SESSIONS

Treatment	Comparison	Test	Vis. Acuity			Manip.	Grip	Bal.	Add.	Mem.	Time Est.	
			Far	Near							Mn.	Var.
P	Across all Sessions	F	-	-	*	-	-	-	-	-	-	-
L	Between B-d1	A	X	X	-	X	X	X	X	X	X	X
A	Baseline B-d2	A	X	X	-	X	X	X	X	X	X	X
C	and B-d3	A	X	X	-	X	X	X	X	X	X	X
E	Dozage B-d4	A	X	X	-	X	X	X	X	X	X	X
B	Sessions B-d5	A	X	X	*	X	X	X	X	X	X	X
O												
S	Across all Sessions	F	*	*	**	**	**	**	**	**	*	*
U	Between B-d1	A	**	-	**	**	**	**	**	**	**	**
O	Baseline B-d2	A	**	*	**	**	**	**	**	**	**	**
P	and B-d3	A	-	*	**	**	**	**	**	**	**	**
O	Dozage B-d4	A	-	*	**	**	**	**	**	**	**	**
L	Sessions B-d5	A	*	*	**	**	**	**	**	**	*	**
A												
M												
I												
N												
E												

KEY: \*\*\* p < .001  
 \*\* p < .01  
 \* p < .05  
 - not significant (p > .05)

X indicates that no test was made; individual comparison A-tests were only performed where the F test showed a significant difference.

A - Sandler's A: Sandler, J. A. A test of the significance of the difference between the means of correlated measures, based on a simplification of student's t. Brit. J. Psychol., 1955, 46, 225-227.



TABLE 8

SIGNIFICANCE OF PERFORMANCE DIFFERENCES BETWEEN PLACEBO AND SCOPOLAMINE GROUPS (t-tests)

Test Sessions	Performance Tests							Time Est.		
	Visual Acuity Far	Visual Acuity Near	Manip.	Grip	Bal.	Add.	Mem.	Mn.	Var.	RT
0	-	-	-	-	-	-	-	-	-	-
b1	-	-	-	-	-	-	-	-	-	-
b2	-	-	-	-	-	-	-	-	-	-
b3	-	-	-	-	-	-	-	-	-	-
b4	-	-	-	-	-	-	-	-	-	-
b5	-	-	-	-	-	-	-	-	-	-
B	-	-	-	-	-	-	-	-	-	-
d1	**	-	**	-	***	**	-	-	-	**
d2	**	**	**	-	***	***	*	-	-	-
d3	*	**	*	-	-	***	-	-	-	-
d4	*	*	-	-	-	*	-	-	-	-
d5	*	*	-	-	-	-	-	-	-	-

KEY: \*\*\* p < .001  
 \*\* p < .01  
 \* p < .05  
 - not significant (p > .05)

NOTE: Visual Acuity t-tests were conducted on Orthorater level values instead of visual angle values.

APPENDIX D

RAW DATA

TABLE 9

VISUAL ACUITY (FAR) PERFORMANCE SCORES  
(in mins. of arc.)

Treatment	Test Sessions														
	0	b1	b2	b3	b4	b5	B	d1	d2	d3	d4	d5			
P	.91	.83	.87	.83	.83	.83	.83	.83	.83	.83	.83	.83			
L	.91	1.00	.96	.91	.87	.91	.89	.91	.91	.96	.91	.91			
A	.96	.83	.83	.87	.87	.87	.87	.83	.83	.83	.83	.87			
B	1.11	1.06	1.00	1.06	1.00	1.00	1.00	.96	.96	.96	.96	.91			
O	1.00	1.06	1.11	.96	.91	.96	.94	1.84	2.25	3.33	2.50	1.11			
S	.91	.91	.91	.87	.83	.91	.87	.96	1.06	.91	.91	.87			
O	1.67	1.67	1.67	1.84	1.84	1.55	.170	1.84	2.25	1.84	1.84	2.00			
O	1.00	1.00	.96	1.00	1.00	1.00	1.00	1.25	1.43	1.18	1.25	1.18			
P	.91	.83	.91	.91	.87	.96	.92	1.00	2.50	1.84	1.34	1.18			
O	1.34	1.43	1.43	1.43	1.67	1.43	1.55	2.50	2.00	1.55	1.55	1.43			
L	.96	.87	.87	.83	.83	.87	.85	1.18	1.43	.91	.96	.91			
A	1.00	.91	.83	.83	.91	.87	.89	.91	1.06	.91	.91	.91			
M	.97	.91	.97	.96	.91	.83	.87	1.06	1.34	1.00	1.06	1.06			
I	1.25	1.25	1.11	1.11	1.18	1.25	1.22	1.84	2.92	2.92	1.25	1.18			
N	1.00	.96	1.00	1.00	.91	1.00	.96	1.06	1.00	1.00	.91	1.00			

NOTE: Sessions 0 - b4 occurred on Day 1  
Sessions b5 - d5 occurred on Day 2

KEY: 0 - orientation  
b1 - baseline test sessions  
d1 - dosage test sessions  
B - Baseline Score: not equivalent to any session score but equal to the average of the last two pre-dosage scores (i.e.,  $\frac{b4 + b5}{2}$ )

TABLE 10  
 VISUAL ACUITY (NEAR) PERFORMANCE SCORES  
 (in mins. of arc.)

Treat- ment	S	Test Sessions														
		0	b1	b2	b3	b4	b5	B	d1	d2	d3	d4	d5			
P	1	.83	.83	.83	.83	.83	.83	.83	.83	.83	.83	.83	.83	.83	.83	.83
L	2	.91	1.00	.87	1.00	.83	.91	.87	1.00	1.00	1.00	1.00	.91	.91	.91	.96
A	3	.83	.83	.83	.83	.83	.83	.83	.83	.83	.83	.83	.83	.83	.83	.83
C	4	1.04	1.11	1.06	1.06	1.06	1.06	1.06	1.06	1.11	1.06	1.06	1.00	1.00	1.11	
E	5	.91	1.00	.87	.96	.87	.96	.92	3.33	5.00	10.00	10.00	10.00	10.00	4.16	
B	6	.87	.87	.87	.87	.83	.96	.90	.91	.96	1.11	.83	.83	.87	.87	
O	7	2.00	1.43	1.55	1.34	1.67	1.43	1.55	1.55	3.33	5.00	2.92	2.92	2.25	2.25	
S	8	.91	.96	.91	.91	.91	.91	.91	1.25	1.67	1.34	1.67	1.67	1.67	1.67	
C	9	.87	.91	.83	.87	.83	.83	.83	1.18	10.00	10.00	3.33	3.33	3.33	3.33	
O	10	.91	.83	.83	.91	.87	.83	.85	.91	.91	1.00	1.00	1.00	1.00	1.06	
P	11	.87	.83	.87	.91	.83	.91	.87	.87	1.18	.91	.96	.96	.83	.83	
O	12	.87	.87	.83	.83	.83	.83	.83	.91	3.33	2.25	1.55	1.55	.91	.91	
L	13	.91	.83	.83	.83	.97	.83	.90	1.25	4.16	2.50	2.92	2.92	1.18	1.18	
A	14	1.06	.96	.91	.91	1.00	.91	.96	1.18	4.16	3.33	1.25	1.25	1.11	1.11	
M	15	.96	1.00	.96	1.00	.96	.91	.94	1.06	1.84	4.16	1.34	1.34	1.25	1.25	

NOTE: Sessions 0 - b4 occurred on Day 1  
 Sessions b5 - d5 occurred on Day 2

KEY: 0 - orientation  
 b1 - baseline test sessions  
 d1 - dosage test sessions  
 B - Baseline Score: not equivalent to a session score but equal to the average of the last two pre-dosage scores (i.e.,  $\frac{b4 + b5}{2}$ )

TABLE 11

MANIPULATION PERFORMANCE SCORES  
(in no. of blocks correctly moved)

Treatment	B	Test Sessions												
		0	b1	b2	b3	b4	b5	B	d1	d2	d3	d4	d5	
P	1	32.0	33.0	37.0	38.0	42.5	41.5	42.0	44.5	44.5	44.5	39.0	40.0	45.0
L	2	42.5	39.5	43.0	39.0	40.5	39.5	40.0	41.5	40.0	40.0	42.5	42.0	44.5
A	3	32.0	34.5	36.5	33.5	35.5	37.0	36.2	39.5	40.0	40.0	37.5	40.0	42.5
C	4	45.5	50.5	50.0	49.5	52.5	52.5	52.5	58.5	61.0	53.1	58.0	58.0	63.0
B	5	41.5	46.5	48.0	51.5	51.5	48.5	50.0	21.5	30.0	33.0	44.0	46.5	
O	6	31.5	33.5	35.0	33.5	33.0	37.0	35.0	31.5	28.0	31.0	35.0	36.0	
B	7	36.5	40.5	38.5	41.0	38.5	35.0	36.8	25.5	23.0	23.5	29.0	35.5	
C	8	45.5	43.0	45.5	47.5	48.0	48.0	48.0	28.0	29.5	36.0	42.0	42.5	
O	9	35.0	37.0	37.0	39.0	44.5	39.5	42.0	23.0	19.5	28.5	35.0	37.0	
L	10	39.5	44.0	41.5	40.0	37.5	40.5	39.0	27.5	33.5	35.0	41.5	44.0	
A	11	40.0	40.5	44.5	41.5	48.5	47.5	48.0	28.5	29.5	39.0	45.0	46.5	
M	12	44.5	45.0	44.5	46.0	48.5	49.5	49.0	30.0	35.0	39.5	44.5	47.5	
I	13	37.0	40.5	42.5	43.5	42.5	47.0	44.8	29.5	26.5	36.0	40.0	46.5	
N	14	41.5	42.5	50.0	49.0	45.5	46.5	46.5	20.5	10.0	27.5	41.0	51.0	
B	15	36.5	37.0	40.0	41.5	42.0	41.5	41.8	25.0	24.5	30.5	34.5	40.0	

EX: 0 - orientation  
b1 - baseline test sessions  
d1 - dosage test sessions  
B - Baseline Score: not equivalent to any session score but equal to the average of the last two pre-dosage scores (i.e.,  $\frac{b4 + b5}{2}$ )

NOTES: Sessions 0 - b4 occurred on Day 1  
Sessions b5 - d5 occurred on Day 2

TABLE 12

GRIP STRENGTH PERFORMANCE SCORES  
(in Kilos squeezed)

Treatment	S	Test Sessions														
		0	b1	b2	b3	b4	b5	B	d1	d2	d3	d4	d5			
P L A C E R O	1	41	40	40	40	38	40	39.0	37	35	32	33	33			
	2	67	64	64	56	68	69	68.5	71	76	74	70	72			
	3	63	66	66	62	64	62	63.0	64	63	63	63	69			
	4	60	63	62	63	64	62	63.0	61	59	57	61	58			
S C O P O L A M I N E	5	57	60	60	55	60	49	51.5	50	51	47	52	64			
	6	46	49	53	46	52	44	48.0	41	45	47	53	55			
	7	44	44	47	43	39	34	36.5	28	27	30	30	36			
	8	55	56	60	58	50	56	53.0	53	53	55	59	58			
	9	52	50	54	57	55	56	55.5	49	54	49	57	60			
	10	49	51	54	50	51	52	51.5	44	52	51	53	57			
	11	53	61	60	59	64	59	61.5	55	55	60	60	62			
	12	61	62	63	61	61	66	63.5	60	63	63	63	61			
	13	68	69	69	68	68	66	67.0	56	59	61	61	64			
	14	54	52	53	51	49	51	50.0	40	41	45	46	50			
	15	61	60	62	65	62	67	64.5	55	56	59	60	60			

KEY: 0 - orientation

b1 - baseline test sessions

d1 - dosage test sessions

B - Baseline Score: not equivalent to any session score but equal to the average of the last two pre-dosage scores (i.e.,  $\frac{b4 + b5}{2}$ )

NOTE: Sessions 0 - b4 occurred on Day 1  
Sessions b5 - d5 occurred on Day 2

TABLE 13

BALANCE PERFORMANCE SCORES  
(in no. of secs. balanced)

Treatment	S	Test Sessions													
		0	b1	b2	b3	b4	b5	B	d1	d2	d3	d4	d5		
P L A C E B O	1	20.0	20.0	20.0	19.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0
	2	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0
	3	19.4	20.0	17.8	20.0	20.0	18.2	19.1	19.2	20.0	20.0	20.0	20.0	20.0	20.0
	4	7.0	7.4	9.7	12.2	11.9	13.0	12.4	20.0	20.0	13.8	20.0	20.0	20.0	20.0
S C O P O L A H I N E	5	20.0	19.2	20.0	11.2	20.0	12.3	16.2	3.0	7.8	14.5	18.5	20.0	20.0	
	6	20.0	20.0	20.0	20.0	20.0	20.0	20.0	7.0	16.3	20.0	20.0	20.0	20.0	
	7	5.8	13.5	15.8	9.6	4.6	16.5	10.6	6.6	6.2	10.8	10.0	10.8	10.8	
	8	8.1	6.8	10.9	15.6	15.8	18.2	17.0	5.2	0	13.6	18.4	13.2	13.2	
	9	16.3	20.0	20.0	20.0	20.0	20.0	20.0	0	8.8	16.0	20.0	20.0	20.0	
	10	17.5	8.6	17.8	20.0	20.0	20.0	20.0	3.2	13.9	14.0	15.9	15.3	15.3	
	11	20.0	20.0	20.0	20.0	20.0	20.0	20.0	3.8	7.8	14.8	20.0	20.0	20.0	
	12	20.0	20.0	14.2	20.0	20.0	20.0	20.0	13.5	16.1	14.1	18.4	20.0	20.0	
	13	19.5	20.0	18.5	19.0	20.0	20.0	20.0	7.5	6.2	17.9	18.4	20.0	20.0	
	14	20.0	20.0	20.0	19.4	20.0	20.0	20.0	3.2	5.0	7.7	10.8	20.0	20.0	
	15	20.0	20.0	20.0	20.0	20.0	20.0	20.0	2.9	3.64	18.4	20.0	19.8	19.8	

NOTE: Sessions 0 - b4 occurred on Day 1  
Sessions b5 - d5 occurred on Day 2

KEY: 0 - orientation  
b1 - baseline test sessions  
d1 - dosage test sessions  
B - Baseline Score; not equivalent to any session score but equal to the average of the last two pre-dosage scores (i.e.,  $\frac{b4 + b5}{2}$ )

TABLE 14

ADDITION PERFORMANCE SCORES  
(in no. problems correctly solved)

Treatment	S	Test Sessions										d3	d4	d5
		0	b1	b2	b3	b4	b5	B	d1	d2	d3			
P L A C E B A O	32	34	34	36	41	37	39.0	43	37	30	35	36		
	40	39	33	38	39	40	39.5	40	39	40	39	39		
	21	26	22	20	27	29	28.0	33	26	34	30	29		
	39	38	36	39	40	41	40.5	45	42	44	44	44		
	30	34	33	30	35	30	32.5	1	0*	0	0	6		
	38	45	33	38	42	38	40.0	25	17	15	26	37		
	43	47	46	48	41	38	39.5	30	1	0	6	4		
	59	66	62	64	63	69	66.0	38	6	18	32	46		
	27	27	25	29	31	33	32.0	0	0*	0	0*	0		
	27	29	32	28	32	35	33.5	25	20	24	25	52		
	35	41	38	42	47	49	48.0	34	6	32	45	46		
	37	45	43	47	48	47	47.5	29*	0*	0*	0*	23		
	29	32	29	28	32	33	32.5	0	0	0	0	16		
	38	39	43	42	44	39	41.5	11	1	7	27	38		
	34	34	36	35	38	42	40.0	21	0	0	29	35		

NOTE: Sessions 0 - b4 occurred on Day 1  
Sessions b5 - d5 occurred on Day 2

\*No problems were tried

KEY: 0 - orientation  
b1 - baseline test sessions  
d1 - dosage test sessions  
P - Baseline Score: not equivalent to any session score but equal to the average of the last two pre-dosage scores (i.e.,  $\frac{b4 + b5}{2}$ )



TABLE 15

MEMORY PERFORMANCE SCORES

(in no. of digits correctly recalled)

Treat- ment	Test Sessions														
	S	0	b1	b2	b3	b4	b5	B	d1	d2	d3	d4	d5		
P	1	6	8	9	8	9	8	8.5	9	8	9	8	9		
L	2	7	7	6	8	7	7	7.0	7	7	9	8	5		
A	3	5	5	6	6	5	6	5.5	6	6	8	5	8		
C	4	5	5	6	4	5	4	4.5	6	6	4	6	5		
E	5	5	5	6	6	8	7	7.5	5	4	6	6	5		
R	6	6	7	6	6	6	7	6.5	5	6	5	6	5		
O	7	7	6	6	7	6	6	6.0	6	6	6	6	6		
	8	8	8	7	8	7	8	7.5	6	6	7	7	7		
	9	5	7	6	6	7	7	7.0	6	4	4	5	5		
	10	6	6	5	7	7	7	7.0	6	5	7	7	6		
	11	5	6	6	7	7	6	6.5	6	4	4	6	7		
	12	8	8	8	7	7	7	7.0	6	6	6	6	6		
	13	8	7	7	7	6	7	6.5	5	5	4	8	6		
	14	5	6	6	7	7	7	7.0	4	4	4	7	7		
	15	8	8	9	9	9	9	9.0	7	6	7	8	7		

NOTE: Sessions 0 - b4 occurred on Day 1  
Sessions b5 - d5 occurred on Day 2

KEY: 0 - orientation  
b1 - baseline test sessions  
d1 - dosage test sessions  
B - Baseline Score: not equivalent to any session score but equal to the average of the last two pre-dosage scores (i.e.,  $\frac{b4 + b5}{2}$ )

TABLE 16

TIME ESTIMATION (MEAT) PERFORMANCE SCORES  
(in no. of secs. estimated as 10 secs.)

Treatment	S	Test Sessions												
		0	b1	b2	b3	b4	b5	B	d1	d2	d3	d4	d5	
P L A C E A O	1	9.75	9.80	9.41	10.06	10.75	10.86	11.30	10.66	10.82	10.08	10.40	9.66	
	2	9.82	11.35	11.51	11.80	9.82	11.19	10.50	13.56	12.16	10.57	13.82	11.43	
	3	7.75	10.25	10.69	10.03	10.26	10.26	10.26	9.63	10.26	9.90	9.62	9.87	
	4	9.47	11.61	9.26	9.38	10.12	9.90	10.01	8.89	9.29	8.51	10.45	8.39	
S C O P O L A M I N E	5	9.95	9.85	9.74	10.56	9.30	10.25	9.78	9.25	8.71	10.50	9.75	9.69	
	6	10.64	8.90	9.44	9.54	9.23	9.30	9.26	7.15	7.97	8.04	7.50	7.97	
	7	9.97	8.10	8.64	8.74	9.06	8.64	8.85	8.44	9.52	7.76	8.09	8.86	
	8	10.02	10.25	12.30	11.96	12.27	14.00	13.14	10.56		12.13	11.36	11.06	
	9	10.06	10.12	10.04	9.34	8.91	9.77	9.34	7.35	6.5	8.46	8.85	8.38	
	10	11.20	9.85	10.14	10.14	10.75	9.14	9.94	9.71	9.30	9.84	9.77	9.62	
	11	10.26	10.22	10.34	9.83	10.63	10.13	10.38	8.61	8.49	8.75	9.01	10.58	
	12	10.73	10.14	10.00	10.28	9.73	10.75	10.24	9.28	9.46	9.19	10.04	9.45	
	13	9.74	9.20	9.63	9.60	9.11	10.83	9.97	8.84	9.73	10.02	9.61	9.39	
	14	10.56	10.42	10.50	9.72	10.78	9.67	10.22	7.16	6.72	7.42	11.25	10.21	
	15	9.82	9.47	8.76	9.31	9.78	10.96	10.37	9.39	9.97	9.64	10.20	9.57	

KEY: 0 - orientation  
 b1 - baseline test sessions  
 d1 - dosage test sessions  
 B - Baseline Score: not equivalent to any session score but equal to the average of the last two pre-dosage scores (i.e.,  $\frac{b4 + b5}{2}$ )

NOTE: Sessions 0 - b4 occurred on Day 1  
 Sessions b5 - d5 occurred on Day 2

TABLE 17

TIME ESTIMATION (VARIANCE) PERFORMANCE SCORES

Treat- ment	S	Test Sessions											
		0	b1	b2	b3	b4	b5	B	d1	d2	d3	d4	d5
P	1	.561	.136	.776	.136	.142	.359	.250	.236	1.413	.145	.061	.165
L	2	1.583	.685	.307	.799	.020	.542	.281	.251	.005	.725	.248	.396
A	3	.731	1.059	1.678	1.365	.363	1.628	.996	1.610	.170	.096	1.255	1.449
C	4	.006	1.183	.011	.367	.469	.107	.288	.103	.221	.332	.112	.162
B	5	.738	.710	.524	.183	.045	1.313	.679	2.015	1.323	4.754	1.326	.714
O	6	.358	.357	.341	.130	.430	.530	.480	.524	.921	.784	.242	.755
S	7	.417	.711	.297	.257	.238	.044	.141	.662	2.706	2.157	.294	.068
C	8	.127	.675	2.943	2.361	.695	1.815	1.255	1.384	5.987	.436	.867	.234
O	9	.110	.179	.049	.181	.057	.076	.066	.137	.482	1.434	.118	.084
P	10	1.014	.059	.584	.642	.335	.248	.292	.760	1.366	.354	.354	1.132
O	11	.311	.664	.669	.196	.432	.320	.376	.845	1.047	.591	.302	.157
L	12	2.153	.827	.050	.248	.270	.106	.188	1.086	.599	.125	.261	.408
A	13	.563	.213	.601	.406	.085	1.207	.646	.212	.230	1.964	3.627	.401
M	14	.479	.539	.501	.119	.282	.905	.594	.149	.915	.836*	.717	2.029
I	15	.124	.448	.091	.360	.479	.239	.359	.028	.116	.458	.038	.135

KEY: 0 - orientation

b1 - baseline test sessions

d1 - dosage test sessions

B - Baseline Score: not equivalent to any session score but equal to the average of the last two pre-dosage scores (i.e.,  $\frac{b4 + b5}{2}$ )

NOTE: Sessions 0 - b4 occurred on Day 1

Sessions b5 - d5 occurred on Day 2

\*Complete set of time estimate scores are missing; entry represents best variance estimate.

TABLE 18  
REACTION TIME PERFORMANCE SCORES  
(in seconds)

Treat- ment	S	Test Sessions														
		0	b1	b2	b3	b4	b5	B	d1	d2	d3	d4	d5			
P L A C E B O	1	.226	.244	.218	.227	.262	.243	.252	.252	.244	.258	.248	.222			
	2	.206	.213	.208	.208	.192	.204	.198	.202	.204	.214	.200	.191			
	3	.220	.211	.256	.228	.234	.256	.245	.224	.228	.292	.222	.231			
	4	.238	.209	.231	.223	.226	.228	.227	.213	.208	.204	.215	.197			
S C O P O L A M I N E	5	.206	.223	.235	.210	.263	.207	.235	.304	.316	.263	.312	.196			
	6	.252	.224	.258	.264	.258	.240	.249	.282	.280	.264	.254	.216			
	7	.225	.206	.210	.196	.188	.217	.202	.260	.242	.247	.222	.203			
	8	.200	.204	.236	.218	.222	.247	.234	.358	.266	.254	.225	.214			
	9	.244	.224	.216	.198	.222	.214	.218	.350	1.015	.232	.210	.201			
	10	.235	.222	.210	.218	.213	.222	.218	.259	.278	.221	.206	.212			
	11	.220	.214	.232	.232	.224	.246	.235	.278	.305	.234	.234	.210			
	12	.316	.278	.276	.250	.276	.246	.261	.304	.287	.275	.254	.254			
	13	.220	.223	.214	.252	.220	.210	.216	.489	.370	.220	.206	.194			
	14	.259	.250	.231	.238	.228	.233	.230	.445	.682	.404	.232	.224			
	15	.204	.186	.186	.180	.191	.180	.186	.267	.310	.238	.198	.198			

NOTE: Sessions 0 - b4 occurred on Day 1  
Sessions b5 - d5 occurred on Day 2

KEY: 0 - orientation  
b1 - baseline test sessions  
d1 - dosage test sessions  
B - Baseline Score: not equivalent to any session score but equal to the average of the last two pre-dosage scores (i.e.,  $\frac{b4 + b5}{2}$ )

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13. ABSTRACT The present Technical Report describes one of a series of studies on the effects of drugs on human performance. The study investigated the effects of Scopolamine (12 gamma/kg.) on the ability of volunteer subjects to perform a variety of tests which represented a wide range of human ability in the areas of Sensory-Perceptual, Psychomotor, Physical Proficiency, and Cognitive performance. The tests included measures of visual acuity, time estimation, reaction time, manual dexterity, balance, grip strength, addition and short term memory. The results showed the following: 1. Scopolamine generally caused a decrement in performance in all tests. 2. In general, performance was poorest from two to four hours after drug administration. 3. Among the abilities studied, Near Visual Acuity was most severely affected, while Grip Strength, Reaction Time and Time Estimation were only slightly affected. It was concluded that the results were encouraging for the continued de- velopment of a Basic Abilities Test Battery. KEYWORDS: DRUGS, SCOPOLAMINE, INCAPACITATION, VOLUNTEERS, SKILL, HUMAN PERFORMANCE, ABILITIES		

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