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FOREWORD

The work described in this report was authorized under Contract No. DA 18-035-AMC-282(A). This work was started in July 1964 and is in progress. This report covers the period from 23 July 1965 to 30 January 1966.

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DIGEST

The aim of the project is the development of a comprehensive battery of ability tests which will evaluate the effects of incapacitating compounds on human performance.

This report summarizes the first and second quarters' effort of Phase II which centered on the following:

1. Detailed analyses of previously collected data as a prerequisite for further testing, resulting in:

    a. refinement of the data analysis techniques

    b. development of a measure of drug effect in terms of the percentage of Ss affected

    c. evaluation of previous tests and recommendations for improvement.

An interim presentation of this analysis entitled: "A method for analyzing response variables to determine the temporal effects of drugs on performance," was given at Edgewood Arsenal on 22 November 1965 by Dr. Wm. J. Baker. The report of this analysis will appear in March 1966 as Technical Report No. 2.

2. Participation in the review of research results of the Summer 1965 Test Series which included ten performance measures developed by AIR.

3. Preparation of Technical Report No. 1 entitled,"Effects of Drugs on Human Performance: Effects of Scopolamine on Representative Human Performance Tests." Elkin, Freedle, Van Cott & Fleishman (August 1965).

4. Presentation of a summary of the first year's effort at EARL entitled, "The effects of drugs on human performance: Laboratory testing and military prediction," to the Contractor's Conference on Behavioral Studies (15 October 1965).

5. Preparation of the First Annual Report entitled, "Effects of Drugs on Human Performance: Research Concepts, Test Development, ad Preliminary Studies." Elkin, Fleishman, Van Cott, Horowitz & Freedle, (October, 1965).

6. Initiation of work on a ast Administrator's Manual for use in a Technician/Test Administrator Training Program, coordinating the efforts of the Psychology and Psychopharmacology Branches of the Medical Research Laboratories.

7. Continued development of new abilities tests, concentrating in the Sensory-Perceptual and Social Abilities areas.

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I. The Detailed Analysis of Drug Effects on Performance

The overall goal of the current project has been the development of a comprehensive test program for evaluating the effects of chemical agents 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. Initial effort concentrated on establishing a Performance Test Battery of abilities basic to many skills. Of some 50 tests recommended for initial tryout for the battery, 20 were developed for study during the first year during which two experiments were conducted to examine the effects on the tests of a 12 μ/kg. dose of scopolamine.

Technical Report No. 1 and the First Annual Report presented the major group trends in the performance data, but did not fully examine all the pertinent information that the data contained. Specific attention was not given to:

a) the degree to which subjects were differentially affected by the drug;

b) the effect of replication during the course of testing;

c) estimates of reliability of each of the tests used;

d) statistical properties of the distributions of scores obtained.

Since each of the above factors adds a great deal to the interpretation of drug effects on any performance variable, specific techniques for their assessment were devised and then applied to the results of Studies I and II. The resulting analysis, which will appear as Technical Report No. 2, permitted the development of specific recommendations for the improvement of tests currently in use, and will serve as a guide in future test development and data analysis.

A summary follows of three of the major considerations involved in the detailed analysis: the mathematical model employed, the resultant "Per Cent Affected Index," and the Test Evaluation.

A. Mathematical Model

The analysis was based on a mathematical model which defined any particular performance score as the summation of the following component factors:

a)   the overall data mean;

b)   the effect associated with each Subject;

c)   the effect associated with each Test Session;

d)   the measure of the extent to which a given observation departs from a simple addition of (a) and (b) (i.e., a measure of non-additivity or interaction required to "explain" the score);

e)   the effect associated with a particular replication;

f)   the sampling error or uncontrolled error variance.

Analyses were conducted which specified each of the components of variance contributing to the score. Where the previous analyses simply compared control and experimental group trends, the revised analysis isolates the residual error variance, and permits more accurate de-lineation of the contribution of the other factors to the performance score. In this way, performance change attributable to the drug may be separated from changes due to other factors present in the environment.

B. Per Cent Affected Index

One major outcome of the analysis was the finding of a subject by session interaction for every test, indicating that subjects were reacting differently to the drug at different points in time. Accordingly, each Subject's test scores were analyzed to determine which among them were, and which were not, showing performance decrement on the different tests and test sessions.

The result of this analysis provided a specification for each test session of the per cent of men whose drugged performance was significantly different from an appropriate baseline performance.

A graph of this type of data is included as Figure 1, illustrating, in terms of the number of men affected, the magnitude of drug effect as a function of time since drug administration for six of the tests in Study I. The figures clearly demonstrate once again, the variability of drug effect on different ability tests.

Potential use of such data may be illustrated by the Far Visual Acuity curve. If, for example, it is assumed that a team of men are unable to perform a mission when more than 25% of them are affected, then 25% becomes a cut-off point indicating that the mission must be accomplished either within the first half-hour following drug exposure, or not until $6\frac{1}{2}$ hours after drug exposure.

Whether this type of information can be used operationally in this manner remains to be seen. Practical information about the relationships between specific performance tests and specific operational missions is not yet available. Nevertheless, the Operations Research and Systems Analysis personnel who must judge operational agent effectiveness will ultimately be dependent on such data for accurate assessment of effects. The above figures, then, represent a step in providing these data.

C. Test Evaluation

A second product of the revised analysis was the evaluation of the tests themselves. The goal of the evaluation was overall test improvement and greater ease of test administration. Table 1 summarizes the recommendations made for each ability test, including its estimated reliability, and the problems, if any, that were noted. The details of the analysis and the reasoning that led to the recommendations are incorporated in Technical Report No. 2.
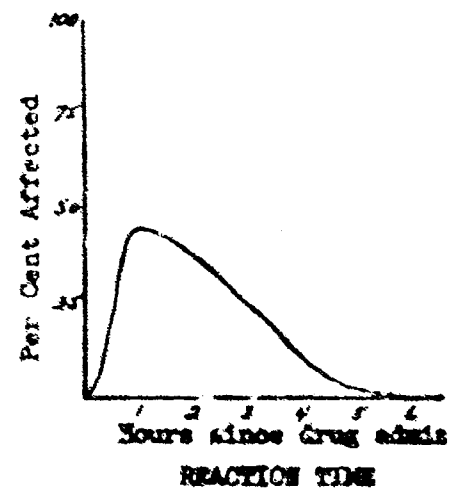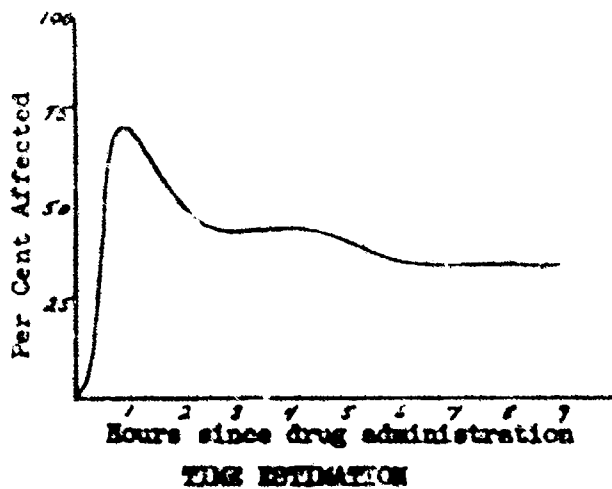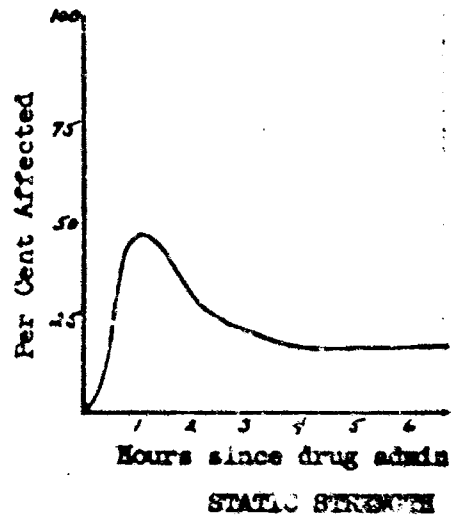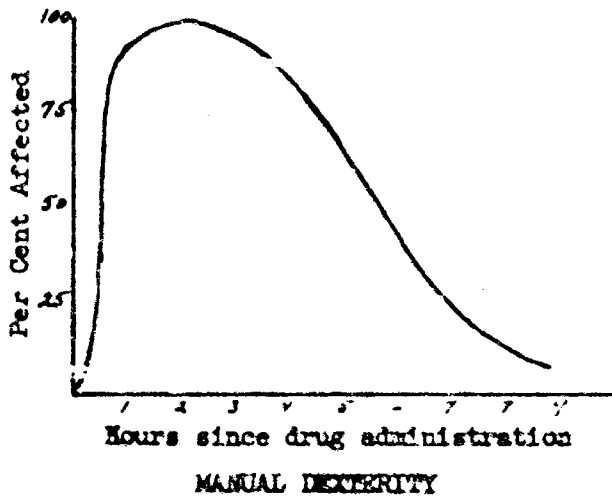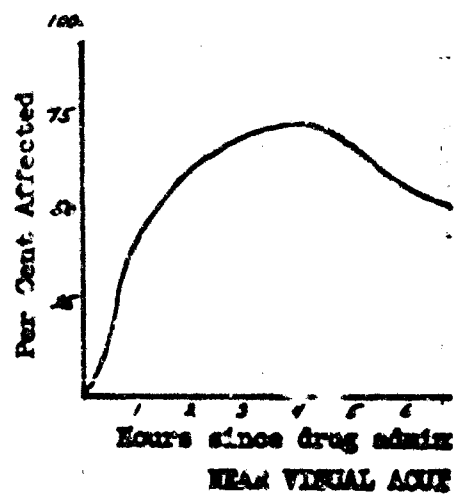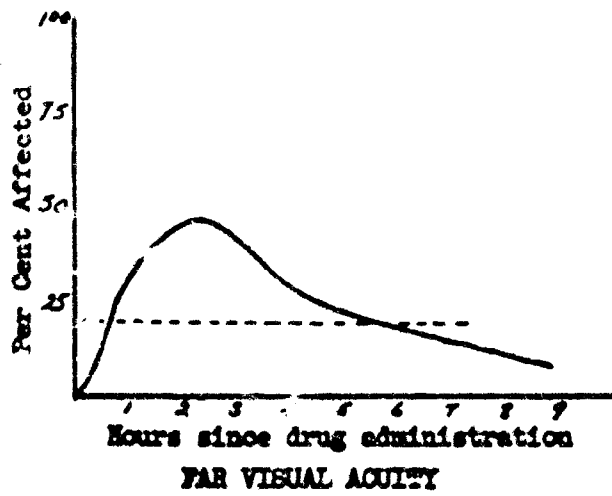
Figure 1. Per Cent of Men Affected (PD > d_j @ .01 level) on Six Representative Performance Measures.

TABLE 1

Recommendations for Modifications of Tests Employed in Studies I and II Based on
Detailed Analyses of Performance Scores

Test Name	Ability Measured	Estimated Reliability[1]	Problem Noted	Recommended Changes
1. ORTHORATER	Vis. Acuity: Far	.92	Inadequate ceiling	Develop different test of acuity to adequately test "better than average" subjects.
	Near	.95	"	
2. MINN. MANIPULATION	Manual Dexterity	.96	None	None
3. HAND DYNOMOMETER	Static Strength	.98	None	None
4. BALANCE A	Gross Body Equilib.	--	Inadequate ceiling	Extend trial time to 1 minute and/or require subjects to keep hands on hips.
5. ADDITION	Number Facility	.82	a. No replication within trials	a. Score odd vs. even items for number correct on each form.
			b. Untestable cases related to loss of visual acuity	b. Develop "flash cards" of items printed large enough to exceed visual acuity losses observed.
6. AUDITORY NO. SPAN	Short Term Memory	.75	a. No replication within trials	a. Separate test items to form two series for each trial.
			b. Inadequate ceiling and base	b. Extend items to an 11 unit group; drop 3 unit group.
7. EMPTY INTERVAL JUDGMENT – Means	Time Estimation	.72	Strong Control Group Interaction	Improve training by continuing to provide knowledge of results in all sessions of pre-baseline testing.
8. EMPTY INTERVAL JUDGMENT – Variance	Time Estimation	.04	Lacks reliability	Eliminate from battery.
9. SIMPLE REACTION TIME	Reaction Time	.71	None	None
10. TRACK TRACING – Time in error	Arm-Hand Steadiness	.80	None	None. Improved test developed permitting scoring of total tracing time.

[1]Average single session estimated reliability based on intra-class correlation coefficients as computed from control subject data.

TABLE 1 (Cont'd.)

Test Name	Ability Measured	Estimated Reliability [1]	Problem Noted	Recommended Changes
11. TRACK TRACING – Number of errors	Arm-Hand Steadiness	.20	Lacks reliability	Eliminate from battery.
12. BROAD JUMP	Explosive Strength	.86	None	None
13. PURDUE PEGBOARD	Finger Dexterity	.70	None	None
14. BLOCK TURNING	Manual Dexterity	.86	None	Drop in favor of Minnesota Manip. for better reliability.
15. PULL-UPS	Dynamic Strength	--	Test too difficult for some undrugged subjects	Drop from battery; substitute Bent-Arm Hang Test.
16. BEND, TWIST & TOUCH	Dynamic Flexibility	.95	No replication	Replicate with two 20-second trials at each session.
17. TWO-HAND COORDINATOR	Multilimb Coordination	.69	Strong Control Group Inter-action	Eliminate from battery, would require extensive pre-training.

[1] Average single session estimated reliability based on intra-class correlation coefficients as computed from control subject data.

Implementation of the recommendations, in terms of a revised set of instructions, is currently under way in the form of a Test Administrator's Manual, designed to guide the personnel at the Human Performance Test Laboratory in administering the various tests incorporated therein. Initially, the Manual will contain instructions for the currently developed tests, but it will be expanded when new tests are developed, and improved when experience with the instructions demonstrates that improvement is needed.

A major portion of the coming quarter will be devoted to the completion of the Test Administrator Manual, and its subsequent use in training a group of Medical Technician/Test Administrators for the laboratory.

E. New Test Developments

In addition to revising and improving the existing tests, several new tests are currently under development, concentrating on the areas that were less emphasized in the first year (e. g., the Sensory-Perceptual and Social).

In the Sensory-Perceptual Area, new tests are being developed to study:

1. Near and Far Visual Acuity
2. Color Discrimination
3. Illusion Susceptibility
4. Rhythm, Pitch, and Loudness Perception

In the Social area, the Crutchfield Conformity Apparatus has been obtained from Shaw Laboratories, and development was begun on a test of interpersonal influence.

Continued test development is planned in the Psychomotor, Physical Proficiency, and Cognitive areas.

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13. ABSTRACT

The aim of the project is the development of a comprehensive battery of ability tests which will evaluate the effects of incapacitating compounds on human performance.

This report presents a summary of the first six month's effort on the second year which concentrated on:

  a) development of an analytical method for detailed evaluation of drug effects on performance
  b) application of the method to supplement previous analyses
  c) development of a "Per Cent Affected Index" in terms of number of men affected.
  d) evaluation and improvement of tests and test procedures
  e) preparation of Technical Report No. 1 and the First Annual Report

  f) continuation of new test development.

Key words: Human Abilities   Drugs   Volunteers
            Incapacitation   Performance Testing

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