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HUMAN PERFORMANCE PREDICTION IN MAN-MACHINE SYSTEMS:

III. A Selected and Annotated Bibliography

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FOREWORD

This report is the third of three volumes constituting the final technical report completed under National Aeronautics and Space Administration Contract NAS2-5038, "Human Performance Prediction Tests." Dr. R. Mark Patton was the NASA Ames Research Center Technical Monitor. This study was performed as a part of the Human Factors Systems Program, Walton L. Jones, M.D., Director.

VOLUME III

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GUIDE TO THE BIBLIOGRAPHY

The subject of "Human Performance Prediction in Man-Machine Systems" can be approached either as a specific problem of prediction for a very limited set of man-machine systems or as an unusually complicated and very broad subset of the total problem of human performance prediction in general. The latter technique is that which has been adopted in this program under the assumption that any source of information or methods for human performance prediction may have some usefulness to human performance in man-machine systems.

The result, as may be seen in this selected bibliography, is a very heterogeneous and very large literature. Consistent with the organization of the technical approach, these some 486 references have been placed in three general classes: Methodological Literature, Tests: Descriptions, Data, and Applications, and Manned Space Vehicles. As might be suspected, even this broad categorization is more of a convenience than based on a rigorous classification taxonomy.

The term "selected" is particularly appropriate since the coverage of the present program could not hope to encompass even a very small portion of the literature. Areas such as stress, small group measurement, personality, manned space vehicles, and so forth, are so voluminous as to exclude anything other than those references felt to be specifically of interest or application to man-machine systems prediction problems, as viewed in this program.

For ease of citation in Volumes I and II the references are listed successively by number (1 through 486) without regard to the categories of this volume. Further, as hopefully a secondary search aid, there is an author index at the end of this volume. Subject index and key word index will have to await a later iteration.

With respect to annotation, very brief citations have been used for the Methodological and Manned Space Vehicles literature principally to keep Volume III within liftable limits. More extensive information has been presented for the Test literature which is needed to supplement Volumes I and II. Nevertheless, we strongly recommend that if a specific test is to be used the original sources should be consulted.

It might be worthwhile to add a comment on the unfortunate parochialism of much of the man-machine system literature. All too often, efforts are proceeding in specific areas with little or no recognition of other related and pertinent developments. Two examples may suffice.

1. Work on describing human tasks in the taxonomic sense is being carried on within human factors, industrial psychology, industrial engineering and several areas of basic psychology. There is little evidence

of cross-communication between these literatures. The result, at present, is a large and technically incoherent set of methods which at best serve very limited purposes and at worst seem to lack any logical, factual, or practical foundation.

2. Man-machine system specialists have a tendency to invent "tests" for specific prediction situations. In too many cases, there appears to be a lack of awareness of the very large body of knowledge available from the classical tests and measurements literature. Further, "tests" are often used in the man-machine systems contexts which are known, in the general literature, to be either questionable or inadequate. It would be rather wise for human factors specialists to make more use of the existing literature rather than exercising their creative ingenuity.

To a great extent, this problem of lack of cross-fertilization pervades all of science and technology today simply because of the enormous amount of literature available, but not easily accessible. But to some extent at least, the cause lies in incomplete scholarship on the part of individual investigators. More literature review and analysis might well be substituted for the premature experimentation that seems to be increasingly filling the literature.

Methodological Literature

Within this general class, five categories have been arbitrarily established:

1. System and Task Analysis. In the present technical framework, no single area is considered more important than to dimensionalize rationally systems and human task processes. This step is essential to the answer to the question: "To Predict What?". Both individual and small group tasks must be predicted. Techniques are plentifully available-task analysis (e.g., 5, 15, 16), factor analytic methods (e.g., 8, 19), scaling techniques (e.g., 20, 24, 29), checklists (e.g., 6, 7), or the classical methods of job analysis (cf., 17). Perhaps the only point of agreement might be that standardization is yet to be achieved.

2. System Performance Measurement. It is sometimes difficult to distinguish in this area between measurement of human performance in system operation and end measures of system performance per se. Many of the measures of "human performance"(e.g., 31, 37, 44) turn out in practice to be system performance measures. A variety of tools are available for such measurement, of course, ranging from full-scale simulation (cf., 30, 35) to specific abstracted tasks (cf., 36), but only one source known to us (41) has clearly distinguished the tools as a function of the kinds and levels of measurement information desired. In fact, this is the criterion problem about which much has been written, but without, apparently, achieving increased understanding and insight. It is rare, indeed, to find a study where the information objectives are clearly stated and the measure sets logically chosen to satisfy those objectives.

3. Individual Measurement Psychological Dimensions. To deal with this measurement problem, one must select some classification system (65). As a heuristic device, some 60 dimensions (out of 75) were specified in Volume I as at least representative of the overall literature in lieu of a necessary and sufficient set of dimensions - a set which has yet to be defined. Some taxonomic structures are available (cf., 51, 63, 65, 73, 77), but they are, at the present time, characterized more by controversy than illumination.

4. Individual Measurement: Stressors and Stress Response. The selectivity of the present bibliography is nowhere more apparent than in this category. The stress literature is truly enormous. Only a very small sample of stress effects in man-machine systems has been included with emphasis on the methodology of measurement (cf., 88, 105, 116). Currently, within the areas of small group stress measurement, there are a number of interesting developments; the work of Haythorn (cf. 97, 98, 99, 119), appears particularly promising.

5. Small Group Measurement. As has been noted in Volume I, the main difficulty - from the standpoint of man-machine systems - with the extremely large small group literature is the lack of emphasis on task dimensions and the correspondingly great over-emphasis on internal dynamics. Within the small group literature, task dimensions are becoming increasingly more recognized (cf., 123, p. 637), but how to handle them remains to be developed.

6. Test Battery Development. In a classical sense, the test performance panels seen in man-machine system research are, in fact, test batteries. However, there sometimes appears to be little awareness of classical methods and requirements by which valid and reliable batteries are supposed to be developed. Some recent developments in this area (cf., 125) are particularly exciting and seem to have specific applications to man-machine system problems.

Tests: Descriptions, Data and Applications

From a very basic methodological and theoretical standpoint, two fundamental choices are available to man-machine specialists with respect to the "test" literature. First, it may be assumed that man-machine system problems are unique in themselves, and, therefore, "tests" should be considered only as they specifically refer to, or are contained in, direct man-machine system tasks. This assumption has been rejected in the present program as (1) too limiting, and (2) inconsistent with the major trends in the literature.

Second, if one can identify within man-machine system tasks basic psychological dimensions, the general psychological test literature may be related to, and potentially available for use in, man-machine system research. Again, however, some conceptual structure is required; as noted, a sturcture of 75 dimensions has been set in this program. No claim is made for this structure other than it serves as a useful

organization of the existing literature, does allow relationships to be established with the general test literature, and appears to have at least some face validity with respect to psychological dimensions contained within manned space vehicle tasks.

Gross body movement dimensions. The term "gross" is perhaps inappropriate and a better term might be "general" body movement dimensions. Our interest is in general, coordinated body movements much as may be required in extravehicular activity. Fleishman's (131) analysis has been accepted as definitive.

Psychological tests. Guided by our dimensional framework, several hundred tests were evaluated from the general literature, and over 400 were selected for the Test Index (see Volume II). The source literature includes such traditional categories as: cognitive, perceptual, visual, psychomotor, memory, personality, and small group (interaction) dimensions. Some, of course, are difficult to classify at all (III. E. Miscellaneous).

Performance panels. An attempt was made to collect all available literature on man-machine performance test panels. This is not a necessarily large leterature; a few well-known names such as Alluisi (cf. 353), Chiles (cf. 356), French (cf. 357), Lincoln (cf. 360, 361), Parker (cf. 19, 190, 373) most frequently appear.

Simulators. There has been no attempt to survey this incredibly large literature. The main interest here has been in methodology (cf. 377, 386, 387), and certain specific simulation techniques (cf., 380, 382, 383, 391) as representative of man-machine system simulation problems in general. The most firmly held assumption in this area is that when all else fails, high "face validity" of simulated task to operational task will insure training, prediction and whatever else one wishes. The few experimental tests of that assumption, however, have been less than encouraging (cf., 30, 388, 389).

Manned Space Vehicles

While several man-machine system contexts outside of manned space vehicles have been considered in this program (cf., 30, 46, 82, 90, 97, 113, 379), the human operator(s) in manned space vehicles has been of prime interest as a source of (1) task domains, (2) behavioral dimensions, (3) measurement analysis, and (4) specific task examples. From a performance prediction standpoint this is at once of major interest in itself, but of unfortunate complexity for a methodological study.

The specific mission example was an extended duration manned earth orbital research laboratory and a rather substantial amount of source documentation was available (cf. 393, 403, 411, 414, 417, 429, 440, 451, 471, 481, 482). Where available in the public literature, Gemini and Apollo experience was, of course, applied. Much use was made of the radiometry experiment (cf., 426).

With respect to manned space vehicles in general, several critical issues still seem in doubt despite the accumulation of actual operational experience. The specific roles of the human operator(s) continue to be questioned; there is yet to be defined a precise set of roles that man can be expected to perform - or not to perform. Prediction of human performance continues to be tested by "high fidelity" part-task or mission simulation (cf. 392, 396, 408, 410) as, apparently, the only technique in which confidence can be placed. Most surprising is the very small literature on the methodology of detailed human performance measurement (cf., 402 407, 410) in the space vehicle context.

From the admittedly parochial point of view of human performance prediction, the most critical need is for precise and quantitative human performance measurement data from manned space vehicle experience. Such data, however, are extremely rare in the open literature, and are inadequate for precise validation of ground-based performance predictions. It may well be that the necessary data will never be available. If this is the case, new partial prediction methods will have to be developed which may, at best, predict boundary limits and not allow specific scalar predictions. For feasibility and advanced system judgments, such methods would be well worth developing in themselves.

VOLUME III

I. METHODOLOGICAL LITERATURE

A. SYSTEM AND TASK ANALYSIS

B. SYSTEM PERFORMANCE MEASUREMENT

C. INDIVIDUAL MEASUREMENT: PSYCHOLOGICAL DIMENSIONS

D. INDIVIDUAL MEASUREMENT: STRESSORS AND STRESS RESPONSES

E. SMALL GROUP MEASUREMENT

F. TEST BATTERY DEVELOPMENT

I. A. System and Task Analysis

1. Altman, I. Aspects of the criterion problem in small group research. I. Behavioral domains to be studied. Acta Psychologica, Amsterdam, 1966, 25(2), 101-131.

A general review of the criterion problem in small group research but with specific orientation toward the group task and the final group output within a general behavioral classification system.

2. Altman, I. Aspects of the criterion problem in small group research. II. The analysis of group tasks. Acta Psychologica, Amsterdam, 1966, 25(3), 199-221.

Continuation of the behavioral classification system with emphasis on the mapping between internal group structure and group structure and group task performance.

3. Armsby, D. H. Task-demands analysis. Human Factors, 1962, 4(6), 381-387.

A technique of task analysis "...which emphasizes definition of task terms, statement of task limits, and a means by which all tasks can be directly and objectively compared and evaluated with respect to their effectiveness."

4. Bergum, B. O. A taxonomic analysis of continuous performance. Perceptual and motor skills, 1966, 23(1), 47-54.

Within the framework of the concept of activation level a wide taxonomy of performance tasks is developed relating task simulation value and task performance.

5. Brooks, F. A., Jr. Operational sequence diagrams. IRE Trans., March 1960, HFE-1(1), 33-34.

A description of the elements of the technique of operational sequence diagrams.

6. Burger, G. C. E., and de Jong, J. R. Aspects of ergonomic job analysis. Ergonomics, 1962, 5(1), 185-201.

An analysis of techniques of job analysis with particular emphasis on physical, perceptual, and mental task load on the operator. A sample checklist is developed.

I. A. System and Task Analysis

7. Christensen, J. M. and Mills, R. G. What does the operator do in complex systems. Human Factors, 1967, 9(4), 329-340.

An attempt, through the use of experienced raters, of deriving behavior classification (based on the task taxonomy of Berliner, Angell, and Shearer) for 31 Air Force jobs.

8. Fleishman, E. A. Performance assessment based on an empirically derived task taxonomy. Human Factors, 1967, 9(4), 349-366.

A summary article presenting the logic, methodology and results of the factor analytic approach to human operator performance. A detailed plan for future work with these tools is outlined.

9. Fleishman, E. A., Kinkade, R. G., and Chambers, A. N. Development of a taxonomy of human performance: A review of the first year's progress. USAF: AFOSR 69-0657, November 1968.

A summary of the results to date of "...the first year of a five year project to develop and verify a taxonomic system for the classification of human task performance." During this initial year, the major efforts on the project proceeded along four lines of activity: (1) review of previous taxonomic efforts, (2) development of an integrative model, (3) development of provisional classification schemes, and (4) development of a human performance data base."

10. Gagné, R. M., and Fleishman, E. A. Psychology and human performance. New York: Holt, Rinehart, and Winston, 1959.

An introductory text but based on the human abilities approach to human behavior as an integrating conceptual framework.

11. Glaser, R. Descriptive variables for the study of task-oriented groups. In Current trends in the description and analysis of behavior. Annual conference proceedings, Dept. of Psychology, Univ. of Pittsburgh, March of 1955-1956. Pittsburgh, Pa.: Univ. of Pittsburgh Press, 1958.

The author suggests the use of three dimensions for a behavior dimension analysis. The dimensions and their variables are as follows:

I. A. System and Task Analysis

COMMUNICATION FLOW: Intra: link frequency, communication frequency, communication significance, input magnitude.
Inter: output irrevocability, intrateam dependence, saturation.

TIME SEQUENCE OR FLOW: Sequence predictability, concurrent activity anticipatory cuing, urgency.

BEHAVIORAL ACTS or process variables: process differentiation; process flow; and possibly group and individual descriptors which imply level of performance (as motivation, leader-member composition, group compatibility, clarity of goal definition, etc.)

12. Hackman, J. R. Toward understanding the role of tasks in behavioral research. USAF: AFOSR-68-1678, 1968.

A thorough analysis of the problem of defining the internal structure of behavioral tasks both in the basic definition of a "task", the description of tasks, and the identification of task factors.

13. Hare, A. P. Handbook of small group research. Glencoe, Ill: The Free Press of Glencoe, 1962.

Task properties developed by Hare are given as: kind or goal of task, criteria for completion, rules or roles required, method of imposing rules, amount of stress on members, and consequences of success or failure.

14. Melton, A. W. The taxonomy of human learning: overview. In A. W. Melton (Ed.) Categories of human learning. New York: Academic Press, 1964. Pp. 325-339.

A detailed analysis of the need for a more meaningful structuring of the basic processes of human learning.

15. Miller, R. B. Task description and analysis. In R. M. Gagné (Ed.) Psychological principles in system development. New York: Holt Rinehart and Winston, 1962, pp. 187-228.

A thorough review of all aspects of task analysis from initial system task description to training specifications.

I. A. System and Task Analysis

16. Miller, R. B. Task taxonomy: science or technology? In W. T. Singleton, R. S. Easterby, and D. C. Whitfield (Eds.) The human operator in complex systems. London: Taylor and Francis, Ltd., 1967, pp. 67-76.

A critical discussion of task taxonomies with a proposed example of an eight-step taxonomy which has been found to be useful in man-machine system design.

17. Morsh, J. E. Job analysis bibliography. USAF: PRL TDR 62 2, March 1962.

A bibliography of research in job analysis from 1911 to 1961 covering over 1,500 references.

18. Palmer. G. J., Jr., and McCormick, E. J. A factor analysis of job activities. J. appl. Psychol., 1961, 45(5), 289-294.

Using a 177-item checklist, job activities were rated for input, decision, storage, and output. High inter-rater reliability was obtained. Factors were derived produced 14 multiple group factors and a second-order analysis produced four general factors.

19. Parker, J. F., Jr. The identification of performance dimensions through factor analysis. Human Factors, 1967, 9(4), 367-373.

An analysis of many of the results obtained to date using the factor analytic approach to structure human operator performance. Of particular interest is the description of the development of a major test battery.

20. Pfeiffer, M. G., and Siegel, A. I. Comparison of category and magnitude scales of technical skills. Perceptual and Motor Skills, 1966, 22(1), 235-248.

Category and magnitude scaling procedures are evaluated for scaling of journeymen electronics personnel job activities. High transformability between the four techniques, high validity and reliability are reported.

21. Roby, T. B. and Lanzetta, J. T. 1958. Considerations in the analysis of group tasks. Psychological Bulletin, 55(2), 88-101.

I. A. System and Task Analysis

Matrix of task properties developed by Roby and Lanzetta is given as:

	descriptive aspects	distributive aspects	functional aspects
task inputs			
group inputs			
group outputs			
task outputs			

22. Schultz, D. G. and Siegel, A. I. Generalized Thurstone and Guttman scales for measuring technical skills in job performance. J. appl. Psychol., 1961, 45(3), 137-142.

Analysis of four naval job specialties and the development of a Scaled Technical Proficiency Check List for evaluation of technical performance against normal performance levels.

23. Schultz, D. G. and Siegel, A. I. Progress and problems in the measurement of individual differences in on-the-job performance. Acta Psychologica, 1963, XXI(2), 120-156.

An extensive review of job performance appraisal techniques with particular emphasis on "dimensionality of performance, criteria, their selection and evaluation, their predictability, their ultimacy and the role of environmental factors."

24. Schultz, D. G. and Siegel, A. I. The analysis of job performance by multidimensional scaling techniques. J. appl. Psychol., 1964, 48(5), 329-335.

A test of multidimensional scaling techniques on the job performance of 65 skilled Naval aviation electronics technicians in 18 tasks. Four basic dimensions, obtained from supervisor's ratings, were derived.

25. Siegel, A. I. and Wolf, J. J. A model for digital simulation of two-operator man-machine systems. Ergonomics, 1962, 5(4), 557-572.

A digital computer simulation of operator tasks in advanced system developments with predictions for task success or failure, operator stress conditions, idle time, team cohesiveness, and time available and unspent.

I. A. System and Task Analysis

26. Silverman, J. A method for structuring technical tasks. USN Personnel Research Activity, Tech. Bulletin STB 66 4, August 1965.

Describes a complex technique for the description of technical tasks in present and future weapons and support systems. "This report describes a statistical technique which has been devised to classify work tasks by their level of complexity." The end objective is to provide a basis for the Navy enlisted classification skill codes.

27. Smith, B. J. Task analysis methods compared for application to training equipment development. USN: NAVTRADEVCEN 1218 5, September 1965.

An analysis of task analysis methods in light of their usefulness for the design of training equipment. "The many methods of task analysis developed for this structuring of behavior into system specification differ widely in the aspect to which they are tailored, in the scope of behavior analyzed, in basic task taxonomy, and even in terminology.

28. Thibaut, J. and Kelley, H. H. The social psychology of groups. New York: John Wiley and Sons, 1959.

Task properties developed by Thibaut and Kelley are given as: Steady vs variable state; fate control vs behavior control; conjunctive (cooperation needed) vs disjunctive group behavior; correspondent vs non-correspondent group behavior for optimal outcomes.

29. Shaw, M. E. Scale analysis of group tasks. Annual Report, Contract Number 580 (11). Gainsville, Florida: University of Florida, October 1962.

Task properties developed by Shaw are given as: cooperation requirements; decision verifiability; difficulty; goal clarity; goal path multiplicity; intellectual-manipulative requirements; intrinsic interest; operational requirements; population familiarity and solution specificity.

I. B. System Performance Measurement

30. Baddeley, A. D. Influence of depth on the manual dexterity of free divers: A comparison between open sea and pressure chamber testing. J. appl. Psychol., 1966, 50(1), 81-85.

Comparisons of performance measurement and decrement obtained in open sea and pressure chamber testing. "Conclusions are (a) the impairment of manual dexterity at depth is considerable when tested under water, (b) it is unwise to generalize from pressure chamber experiments to under water performance."

31. Bahrick, H. P. and Noble, M. E. Motor behavior. In J. B. Sidowski (Ed.) Experimental methods and instrumentation in psychology. New York: McGraw-Hill, 1966. Chapter 16, 645-675.

A thorough review of the measures, and transformations of those measures, of human motor performance. Thirteen major measures and their intercorrelations are discussed. Original data measures and their factor analytic structure are presented.

32. Berliner, D. C., Angell, D. and Shearer, J. W. Behaviors, measures, and instruments for performance evaluation in simulated environments. Paper presented at Symposium and Workshop on the Quantification of Human Performance, Albuquerque, 17-19 August 1964.

A review of performance measurement problems in simulation under the following topics: (1) need for measurement capabilities in simulators, (2) development of criteria, (3) parameters of performance evaluation, and (4) approach to analyzing interrelationships between parameters. Presents a task classification system in terms of perceptual, mediational, communication, and motor processes.

33. Buckhout, R. A bibliography on aircrew proficiency measurement. USAF: MRL-TDR-62-49, May 1962.

A selective review of the literature on combat aircrew proficiency measurement in six areas: (1) first order measurement, (2) combination measures, (3) validation, (4) measurement equipment, (5) general analyses and reviews and (6) background reports.

34. Curtis, E. W. Necessity/sufficiency as a conceptual model for predictor-criterion relationships. USN: Personnel Research Activity STB 67-17, January 1967.

"The concepts of necessity and sufficiency are presented as the basis for understanding various predictor-criterion relationships. Three types of strong relationships are introduced as models for the

discovery, utilization, and evaluation of predictors: (1) 'necessary-and-sufficient', the conventional symmetrical relationship where the frequencies in two cells of the four-fold table appraoch zero as the assocation increases. (2) 'necessary-but-not-sufficient', the asymmetrical relationship where the frequency is only the false-positive cell approaches zero, and (3) 'sufficient-but-not-necessary', the asymmetrical relationship where the frequency in only the false-negative cell approaches zero." The traditional emphasis on (1) is inadequate for conditions (2) and (3). And the exclusive use of (1) may mean "that many potentially useful predictors have been discarded as useless."

35. Grodsky, M. A. The use of full scale mission simulation for the assessment of complex operator performance. Human Factors, 1967, 9(4), 341-348.

A description of the use of a high fidelity simulation of human operator performance with emphasis on the methodology of simulation and test and the selection of the appropriate test situation to predict operational performance.

36. Jex, H. R., McDonnell, J. D. and Phatak, A. V. A "critical tracking task for manual control research. IEEE Trans. Human Factors in Electronics, December 1966, HFE-7(4), 138-145.

A tracking task designed to provide a basic test situation using an increasingly unstable first-order controlled element to loss of operator control. Measurement sets based on the human operator describing function technique.

37. Kelley, C. R. The measurement of tracking proficiency. Human Factors, 1969, 11(1), 43-64.

A critical review of the literature on techniques for the measurement of continuous manual control. Five classes of measurement are noted: (1) single-axis error amplitude scores, (2) multi-axis error amplitude scores, (3) simple frequency scores, (4) special engineering measurement techniques, and (5) adaptive tracking measurements.

38. Knowles, W. B. Operator loading tasks. Human Factors, 1963, 5(2), 155-161.

A critical review of the technique of measuring operator workload through secondary task performance scores: "...it is suggested that

a set of standardized tasks should be developed so that more nearly comparable measures could be obtained over a wide range of primary tasks."

39. Lathrop, R. G. Some principles for development of new measures of human continuous performance. Perceptual and Motor Skills, 1965, 20(2), 453-458.

Concerned with the measurement of human operator tracking performance with respect to theoretical implications of the measure(s), statistical adequacy, validity and reliability, and relationships with other performance measures.

40. Locke, E. A., Zavala, A. and Fleishman, E. A. Studies of helicopter pilot performance: II. The analysis of task dimensions. Human Factors, 1965, 7(3), 285-302.

An empirical study of helicopter pilot proficiency from the factor analytic approach. Six factors were identified for both primary and basic training. Nine factors were identified for primary training; 11 factors for basic training.

41. Obermayer, R. W. Simulation, models and games: sources of measurement. Human Factors, 1964, 6(6), 607-619.

Simulations, models and games are viewed as techniques by which various levels of abstraction from real system performance are generated. From these techniques various measure sets are derived to satisfy information objectives.

42. Poulton, E. C. On increasing the sensitivity of measures of performance. Ergonomics, 1965, 8(1), 69-76.

Several methods are discussed for increasing measure sensitivity: adjusting task difficulty, use of a secondary task to load the operator, using tasks unfamiliar to the subject, using measures of variability rather than mean performance, measuring specific events in time rather than summing over extended periods of time.

43. Rolfe, J. M. The use of multi-task situations to investigate human performance. RAF Institute of Aviation Medicine, Farnborough, IAM Report No. 333, December 1965.

I. B. System Performance Measurement

"Various ways in which secondary tasks have been used for experimental purposes are described and the findings obtained from the investigation are summarized." Four general categories of applications are noted: (1) comparison of alternative methods of task performance, (2) evaluation of work load, (3) evaluation of operator capacity to learn to control multiple-task loads, and (4) the operator's capacity to handle information from a variety of sources.

44. Smode, A. F., Gruber, and Ely, J. R. The measurement of advanced flight vehicle crew proficiency in synthetic ground environments. USAF: MRL-TDR-62-2, February 1962.

A classical and extensive review of the concepts, methods and tools for measuring human performance in simulated environments.

45. Trumbo, D., Eslinger, R., Noble, M., and Cross, K. A versatile electronic tracking apparatus (VETA). Perceptual and Motor Skills, 1963, 16(3), 649-656.

An electronic tracking and scoring system is described with magnetic tape recording. Extensive variations in the nature of the input signal are possible.

46. Zavala, A., Locke, E. A., Van Cott, H. P. and Fleishman, E. A. Studies of helicopter pilot performance: I. The analysis of maneuver dimensions. Human Factors, 1965, 7(3), 273-283.

"Measures of helicopter pilot proficiency were obtained on samples of student pilots in two training phases. Measures were based on students' performance on 16 and 12 separate maneuvers in the Primary and Basic training phases respectively. Intercorrelations of maneuvers in each phase were subjected to factor analysis. In both phases maneuver performance could be described in terms of six or seven clearly interpretable common factors."

I. C. Individual Measurement: Psychological Dimensions

47. Abbey, D. S. Control-display-subject interaction and performance on a complex perceptual-motor task. Ergonomics, 1964, 7(2), 151-164.

The Toronto Complex Coordinator is used to demonstrate performance predictions for control-display linkages, display locations, and spatial position of the operator relative to controls and displays.

48. Allison, R. B., Jr. Learning parameters and human abilities. Office of Naval Research contracts Nonr-694(00) and Nonr 1858-(15) and National Science Foundation Grant G-642. Princeton University and Educational Testing Service, Princeton, New Jersey, May 1960. AD 418 235.

Subjects: 315 Naval recruits, aged 17 to 22 years. Average IQ in low 90's. The data for those subjects who were uncooperative or were not present for all of the tests were not included.

Method: The tests and tasks were group administered and motivation was provided by self-scoring (scores were rechecked). Thirteen tasks were administered with from 5 to 15 trials each. Two learning parameters were derived from each of the thirteen learning curves - learning rate (average) and acceleration locus (early or late occurance of more rapid learning). For two of the learning curves (Sidewalk maze and Rotary pursuit) an initial performance level was also used for a learning parameter. Thirty eight ability reference measures were used, including 36 tests, age and education level. The reference measures were selected to measure the following abilities: rote associative memory, induction, general reasoning, deduction, verbal knowledge, spatial orientation and visualization, mechanical knowledge, number facility, aiming, motor speed, manual dexterity, perceptual speed, speed of association and intelligence.

Results: (Note: factors were oblique) A multiple-factor analysis performed on the 28 learning parameters alone produced 12 factors, of which 5 were not identified. Three of the identified factors were rote learning factors: general rote learning specific to the rate parameter, general rote learning specific to the acceleration parameter, and spatial rote learning specific to the rate parameter. The other four factors include Verbal Conceptual Learning, Spatial Conceptual Learning, Mechanical-Motor Learning, and "Early vs. Late" Learning.

A second factor analysis was performed using Tucker's inter-battery method. The reference measures factors were as follows: Intellectual Ability, Generalized Mechanical Ability, Rote Memory, Numerical Ability, Wrist-Finger Speed, and two unidentified factors.

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The learning parameters factors were: Conceptual Learning, Mechanical-Motor Learning, Rote Learning, Control Precision, and three unidentified factors. The correlations between the learning parameters factors and the reference measures factors indicated particularly close relationships between the learning domain and the human ability domain which may be represented by the following inter-battery factors: Conceptual Process Factor, Rote Process Factor, Mechanical Factor, and Psychomotor Coordination Factor.

49. Alluisi, E. A. Methodology in the use of synthetic tasks to assess complex performance. Human Factors, 1967, 9(4), 375-384.

A summary presentation of the results obtained to date on a multiple-task test battery based on six major performance dimensions. Detailed information is provided on validity and reliability of the test battery.

50. Bevan, W., Egeth, H. and Avant, L. The evolution of perceptual frames of reference. Technical Reports 57-60, ONR contract N00014-67-A-0163-001. Dept. of Psychology, The Johns Hopkins University, Baltimore, Md., December 1968.

The results of the research covered by Technical Report 60 led the author to comment on the apparent independence and serial execution of stimulus decision and response decision processes. A two-choice reaction time test was used.

51. Burt, C. The structure of the mind: a review of the results of factor analysis. Brit. J. educ. Psychol., 1949, 19, 100-111, 176-199.

The first major presentation of the modern British concept of a hierarchical structure of human ability postulating four successive levels of abilities: relations, associations, perception and sensation.

52. Chiles, W. D. Methodology in the assessment of complex performance: discussion and conclusion. Human Factors, 1967, 9(4), 385-392.

Presents results of a technical questionnaire administered to 15 experts as to their opinion on 35 technical questions, specifically with reference to the basic issues in the measurement of human operator performance.

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53. Cooley, W. W. and Lohnes, P. R. Multivariate procedures for the behavioral sciences. New York: John Wiley and Sons, 1962.

54. Edwards, E. Conservatism in human information processing. In B. Kleinmuntz (Ed.) Formal representation of human judgment. New York: John Wiley and Sons, 1968, 17-51.

The current status of conservatism theory and research is presented. Conservatism is a decision theory construct within the human information processing framework based on the empirical evidence that the human changes his opinion very conservatively in the light of new information; i.e., the subjective estimate of the probability of an event is usually lower than the mathematical probability based on the available information.

55. Edwards, W. A bibliography of research on behavioral decision processes to 1968. NASA Grant NGR-23-005-171. Memorandom Report No. 7, Human Performance Center, University of Michigan, Ann Arbor, Michigan, January 1969.

Lists 1393 references which represent selected literatures on the human decision processes dating from the 1930's to early 1968.

56. Ferguson, G. A. Human abilities. Annual Review of Psychology. Palo Alto: Annual Review, Inc., 1965. Volume 16, 39-62.

A comprehensive review of the human abilities literature for the period "1960 to early 1964", with particular emphasis on the organization of human abilities.

57. Fleishman, E. A. The structure and measurement of physical fitness. Englewood Cliffs, N. J.: Prentice-Hall, Inc., 1964.

A brilliant analysis of physical fitness tests and measures conceptualizing, through factor analytic techniques, the basic dimensions of physical fitness and deriving Basic Physical Fitness tests.

58. Fleishman, E. A. Human abilities and the acquisition of skill: Comments on Professor Jones' paper. In E. A. Bilodeau (Ed.) Acquisition of skill. New York: Academic Press, 1966, 147-167.

In specific response to a paper of Jones (1966), reviews the factor analytic appraoch to motor abilities and performance discussing

(1) the ability-skill distinction, (2) abilities and skill learning, (3) taxonomy of perceptual-motor abilities, (4) skill acquisition, and (5) individual differences in retention.

59. Fleishman, E. A. and Bartlett, C. J. Human abilities. Annual Review of Psychology, 1969, 20, 349-380.

The article provides a comprehensive review of much of the literature and developments during the 1964 through early 1968 time period. A major development discussed was the increased attention being given to individual differences in learning research. The comparative results of adequate and inadequate ability considerations and experimental designs, when dealing with the definition of effects on performance, are spotlighted.

60. Fleishman, E. A., Kinkade, R. G. and Chambers, A. N. Development of a taxonomy of human performance: a review of the first year's progress. AFOSR 69-0657 TR, Advanced Research Projects Agency, Department of Defense Contract No. F44620-67-C-0116. American Institutes for Research, Washington, D. C., November 1968.

This report describes progress during the first year of a five year effort to develop and verify a taxonomic system for the classification of human task performance. Thus far, two provisional classification schemes are under development, one based on abilities, the other based on observable task characteristics.

61. Freedle, R. O., Zavala, A. and Fleishman, E. A. Studies of component-total task relations: order of component-total task practice and total task predictability. Human Factors, 1968, 10(3), 283-296.

Component-total task relationships were examined when component tasks of the Complex Coordination Task were practiced in different orders. The part tasks were as follows: single level: one rudder, one direction stick control, the other direction stick control; double level: both direction stick, rudder and one direction stick, rudder and other direction stick. From the correlational analyses it was determined: order of part-task practice affects total task proficiency. Also, part-task scores can be combined in a statistically independent manner to predict more complex task performance only when a specific double-level task is combined with a specific single-level task. And prior practice on double-level tasks led to better total task proficiency than did prior practice on single-level tasks.

The authors indicate that this study suggested some limits to the generality of the Independence Hypothesis. Further they specified a series of interlocking studies that would be necessary to determine the most efficient training method for any one task.

62. Glanzer, Murray. Individual performance, R-R theory and perception. New York University, New York. Contract DA-49-193-MD-2496. May 1966.

Author comments that satisfactory R-R experimentation requires that:
1. The intervening process be specified.
2. The intervening process within the individual be specified
3. That the process be available to experimentation.

Author comments that factor analysis does not satisfy (1) above, but rather gives performance components.

63. Guilford, J. P. The nature of human intelligence. New York: McGraw-Hill, 1967.

The most complete theoretical presentation of the Structure-of-Intellect (SI) model developed by Guilford organizing the factor analytic knowledge of human abilities into a three-dimensional model of product (six categories), content (four categories), and operation (five categories).

64. Guilford, J. P. and Hoepfner, R. Structure-of-Intellect factors and their tests, 1966. Report No. 36, Psychological Lab., Univ. of Southern California, Los Angeles, California, June 1966. AD 489 528 Limited.

The Structure-of-Intellect model is briefly defined and the best tests for the model components specified. The sources to be contacted or obtained for copies or information of SI tests are listed. A matrix is provided which lists all the proposed SI cells, their common name if one exists, and the reports which have identified them.

65. Humphreys, L. G. The organization of human abilities. American Psychologist, 1962, 17(7), 475-483.

A review and critical discussion of the recent conceptual frameworks in evolution for the understanding of the structure and order of human abilities, with particular emphasis on the hierarchical model and facet theory.

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66. Ismail, A. H., Falls, H. B., and MacLeod, D. F. Development of a criterion for physical fitness tests from factor analysis results. J. appl. Physiol., 1965, 20(5), 991-999.

"The purpose of the study is two-fold: a) to illustrate a method whereby it is possible to combine the various criteria for physical fitness to form one composite criterion; and b) to develop physical fitness test batteries. As a result, a method for combining the various criteria of physical fitness tests into one composite criterion was described. Furthermore, physical fitness test batteries were developed."

67. Jones, M. B. Individual differences. In E. A. Bilodeau (Ed.) Acquisition of skill. New York: Academic Press, 1966. 109-146.

Extensive review of the literature on test data on the acquisition of human operator performance skills covering (1) acquisition, (2) relearning and recall, (3) inheritance, task classification, (4) selection, and (5) training.

68. Locke, E. A. and Bryan, Judith F. Cognitive aspects of psychomotor performance: The effects of performance goals on level of performance. J. appl. Psychol., 1966, 50(4), 286-291.

Performance levels achieved by subjects depended upon the specific nature of the performance criteria standards set for the subjects.

69. Martin, E. Relation between stimulus recognition and paired associate learning. Journal of Experimental Psychology, 1967, 74, 500-505.

The experimental evidence supported the hypotheses that association activation, as evidenced by correct responding, is contingent upon stimulus recognition but that stimulus recognition is not dependent on the existence of responses. The subjects were given practice on trigram-number pairs and subsequently tested on these pairs intermixed with others. The subject had to first make a stimulus-recognition response and then a number response.

70. Melching, W. H. Measures of ability and programmed instruction performance. Dept. of the Army Contract DA 44-188-ARO-2 (DA Project 2J024701A712 01), Tech. Report 65-12, Human Resources Research Office, George Washington University, Washington, D. C., December 1965. (AD 629 443).

Subjects: A total of 168 enlisted army personnel; each instruction program involved 10 to 50 men.

Method: The results of several programmed instruction studies were compared with respect to relationships between measures of ability and measures of instruction performance. The data from six instruction programs were utilized. The programs dealt with DC circuits, mathematics, magnetism and counterinsurgency and varied in length from 99 to 3200 frames. Some were group and others individually administered with a variety of response formats. The instruction performance measures included the test score, time required, and the program error.

Three ability measures were used: Arithmetic Reasoning Test (AR), Verbal Test (VE), and an average of the AR and VE scores (GT). 47 of the 60 possible correlations between the instruction performance measures and the ability measures were significant at the .05 level or better. Also of interest was the finding that, as time available to the subjects for study of the instruction program increased, the abilities tended to show less relationship to the program time required measure and a greater relationship with achievement, or the program test score.

71. Melton, A. W. First annual report: Human information handling processes. AFOSR 69-0486TR, Contract AF 49(638)-1736. Human Performance Center, University of Michigan, Ann Arbor, Michigan, June 1968. (AD 683 735)

The first year's experimental results and theoretic progress are reported. The topics include: taxonomy of information handling processes, selective information handling processes, information storage and retrieval, and refinement of some short-term-memory methods and measures. Of interest were the author's comments to the effect that short term and associative memory were found to be involved in a far larger set of tasks then expected (p. 18). Included in this set were choice reaction time, search, reaction time and information processing tasks.

72. Passey, G. E. and McLaurin, W. A. Perceptual-psychomotor tests in aircrew selection: historical review and advanced concepts. PRL-TR-66-4, Personnel Research Laboratory, Aerospace Medical Division, Air Force Systems Command, Lackland AFB, Texas, June 1966. (AD 636 606).

The report reviews the literature reflecting the employment of perceptual-psychomotor tests for selection of aircrew members since WW II and provides behavior functions for consideration as possible

future test development areas. The review considers the use of flight experience as well as perceptual-psychomotor screening devices and comments on the results of the programs in which such experience is intentionally used. The fundamental importance of criterion to development and validation of selection devices is discussed. Recent research is reviewed leading to the derivation of behavioral functions recommended for consideration as principles on which new perceptual-psychomotor tests may be based. The functions are: learning rate, automatization of response, paced and unpaced performance, endurance under prolonged operation, performance variability, distraction resistance, adaptability, kinesthetic discrimination, psychomotor ability, concurrent information processing, anticipatory behavior, "ridility", short-term memory, perceptual speed, attention, estimation, interference, discrimination reaction time, and visualization. The merits of simple tests as opposed to complex tests in which numerous facets of performance are concurrently assessed are considered.

73. Pew, R. W. Human information-processing concepts for system engineers. In R. E. Machol (Ed.) System engineering handbook. New York: McGraw-Hill, 1965, 31-3 - 31-19.

"Recent developments in the study of human performance and the accumulating experience of human-factors designers suggests that an important unifying concept for design of man-machine systems lies in the view of man as a single-channel, limited-transmission-capacity, information-processing system. This view regards man as an information channel in the cybernetic sense rather than as an energy converter or power supply...

"Primarily for purposes of exposition, the human information-processing system has been broken down into the four subsystems... read-in, memory or storage, information processing or decision making, and read-out." (p31-4) The author comments that the single-channel system viewpoint should not, however, be taken too literally.

74. Robins, J. E., McKendry, J. M. and Hurst, P. M. Task-induced stress: a literature survey. Contract No. AF33(616)-7892, Aerospace Medical Laboratory, Aeronautical Systems Div., AF Systems Command, USAF, Wright-Patterson AFB, Ohio. HRB-Singer, Inc., State College, Pa., October 27, 1961. (AD 667 272)

The information gathered from the literature survey covers the following topics: the meaning of stress, individual differences in stress reactions, task induced stress and the control of stress.

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75. Summers, L. G. and Ziedman, K. A study of manual control methodology with annotated bibliography. NASA Contractor Report 125, Contract No. NASw-717. TRW Space Technology Laboratories, Redondo Beach, California, November 1964.

Provides a comprehensive review with an associated annotated bibliography of the approaches which have been developed to describe the human as a controller. The reviewed approaches were divided into two classifications and their usefulness and possible connections with each other studied: (1) the study of perceptual-motor-behavior as performed by the general or engineering psychologist and (2) the application of mathematical models based on control theory to the description of the human operator.

76. Teichner, W. H. and Olson, Diane. Predicting human performance in space environments. NASA Contractor Report 1370. Harvard University, Boston, Mass., June 1969.

The authors' primary concern is the prediction of performance in stressful environments over different periods of time. A classification scheme for the description of tasks was developed using the categories of searching, switching, coding, tracking, and complex tasks. The man is described in terms of a processing model for assumed CNS functions. The prediction effort focuses on the effects of environment on the above named task categories.

77. Vernon, P. E. The structure of human abilities. New York: John Wiley, 1949.

A major theoretical contribution to the factor analytic modelling of human ability based on an hierarchical structure stemming from "g" into major group factors, minor group factors, and specific factors.

78. Witkin, H. A., Lewis, H. B., Hertzman, M., Mackover, K., Meissner, P.B. and Wapner, S. Personality through perception. New York: Harper, 1954.

Presents the findings of an extensive research program which investigated the ramifications of and the predictors of perceptual behavior. The primary perceptual measurements were taken on three variations of the Rod and Frame Test and a modified Gottschaldt Figures Test. The better performers on both tests were termed the Field Independents. This differentiation on the basis of perceptual behavior was highly related to other behaviors and personality test measurements.

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79. Witkin, H. A., Dyk, R. B., Faterson, H. F., Goodnough, D. R. and Karp, S. A. Psychological differentiation. New York: John Wiley and Sons, 1962.

Presents the further evolvement of a differentiation of self construct based on studies to date using Field Dependent vs. Field Independent subject categorization.

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80. Barrett, G. V., Thornton, C. L. and Cabe, P.A. Relation between Embedded Figures Test performance and simulator behavior. Journal of Applied Psychology, 1969, 53, 253-254.

"Relationships previously found with reaction to an emergency situation and simulator sickness compared to the Rod and Frame Test (RFT) measure of perceptual style were extended using a second perceptual style measure, an Embedded Figures Test (EFT). The RFT was significantly related to emergency behavior and simulator sickness. The EFT was significantly related to emergency behavior but not to the simulator sickness." (Author's abstract) The emergency criteria were the initial brake reaction time and the deceleration rate when a human dummy suddenly appeared on the displayed highway. The test correlations with the criteria ranged from .49 to .74.

81. Blockley, W. V. and Lyman, J. Studies of human tolerance for extreme heat: IV. Psychomotor performance of pilots as indicated by a task simulating aircraft instrument flight. Contract No. W-33-038-AC-14504, Tech. Report No. 6521, WADC, Research Div., Wright-Patterson AFB, Dayton, Ohio. University of California, Berkely, California. May, 1951. (ATI 119 608, Reel C-5539)

Subjects: 4 pilots.

Measure: the performance measure was a combination of error scores.

Method: Performance was measured under 80°, 160°, 200° and 235° F conditions. The pilots flew flight patterns with a simulated airplane cockpit developed from several Link Trainers. The patterns were repeated over a period of 20 minutes or less with the exception of the 80° practice and control sessions. The heat stress sessions were terminated in accordance with previously established heat tolerance criteria.

Results: The authors indicate that there were no important differences between the 80° performances and the early periods of the heat stress performance. Performance at the 200° and 235° levels deteriorated markedly for all subjects but to a much lesser extent for the more competent subjects (as determined by the 80° performance).

82. Bowen, H. M. Diver performance and the effects of cold. Human Factors, 1968, 10(5), 445-464.

Review of the results of performance testing of divers. Data are presented from a "test battery composed of tests of tactile sensitivity, grip strength, manual dexterity, tracking, assembly of a

structure by groups, mental arithmetic, symbol processing, simple problem solving and memory."

83. Bowen, H. M., Andersen, G., and Promisel, D. Studies of divers' performance during the Sealab II Project. Human Factors, 1966, 8(3), 183-199.

Results of psychological testing in the Sealab II project based on three 10 man diving teams. "Compared to base line performance (dry-land and shallow water conditions), performance on the mental arithmetic test showed no deterioration while performance on the psychomotor tests showed considerable deterioration."

84. Chambers, R. M. Isolation and disorientation. In J. D. Hardy, (Ed.) Physiological problems in space exploration. Springfield, Ill., Charles C. Thomas, 1964.

The following are degradations which occur during prolonged isolation and confinement to skill performance proficiency measured quantitatively. Complete definitions are given in the text.
Lapses - increasing temporary decrements. Approximation- minimally adequate. Sterotyping - similar responses to all stimuli. Increased range of indifference - less difference perceived between differing stimuli. Filtering - Subject selectively responds to only some task stimuli. Response omission - omitting parts of task. Queuing - delaying responses to a less loaded time. Increased latency of response, increased error amplitudes, and more process errors.
Authors comment: above are highly variable, difficult to measure and very sensitive to changes in the test conditions.

"Psychomotor performance, as on a rotary pursuit task or a reversed digit writing task, shows decrement after 24 hr. Attention span shortens, and some visual illusions of pattern change and movement occur. Lapses occur briefly and frequently, and they are disruptive to vigilance and any other ongoing behavior which requires concentration. By the 72nd hour of sleep deprivation, immediate memory and ability to reverse digits drops severely. The loss of peripheral vision and the loss of fine movements of the eyes results in a marked tendency to stare. Visual sensations may include diplopia, illusions, and impressions of fog, mist and visual imagery. Task performance decrement continues progressively, although well learned semi-automatic performance is possible for short periods. Attention to external sensory input requires greater sympathetic arousal... By the fourth day of sleep deprivation, relatively severe memory losses occur, and there is a marked sterotyping of motor responses. Misconceptions, disorientation and hallucinations are frequent.....

Stationary objects appear to have rhythmical movements at times, and visual imagery of complex geometric designs occur frequently. At the end of the fifth day, psychotic symptoms appear, gross mental aberrations occur, and prolonged disorientation in terms of time, place, person and one's self is commonly reported." "...After the termination of the sleep deprivation period, psycholoical and physiological after-effects may be present from 7 to 10 days."

Four kinds of time for the astronaut: clock time, geographic time, physiologic time and psychologic time.

Confinement extending to eight days duration distorts ability to judge the passage of time has been demonstrated by a number of studies, but 8 to 12 hour confinement has not.

Time estimation is said to be a function of several factors.

"...extensive personality, biochemical, performance and physiological tests conducted before, during and after these exposures, have not shown any significant personality or emotional effects. Since these are observed overtly, but not measured by means of quantitative tests, it is generally concluded that the tests are not themselves sensitive enough to measure the subtle personality effects, even if they do occur." under "conditions reported to be extremely aggravating and sometimes disturbing."

85. Clark, B. and Graybiel, A. The break-off phenomenon: a feeling of spearation from the earth experienced by pilots at high altitude. Research Project NM 001 110 100, Report No. 43, Naval School of Aviation Medicine, Pensacola, Florida, August 6, 1956. (AD 128 202)

"The predisposing factors have not been identified, but they appear to be related to the personality of the flyer. The cardinal precipitating factors are flying alone, at high altitude, with relatively little to do. The chief subjective feelings are those of remoteness, loneliness, and anxiety or exhiliration; there may be expressions of anxiety ranging from increased alertness to a fear of moving about in the seat. The break-off effect is abolished readily by a return to a lower altitude, joining up with another plane, and oftimes by a voluntary effort to become interested in some problem or activity associated with the flight."

Subjects: 137 jet aviators in the Navy and Marine Corps. Experience in jets ranged from 100 to 2200 hours with a median of 330 hours. Median age was 27.4 years.

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Method: Individual interviews were given, using a pre-established question format. Specific questions related to emotional reactions to flight were asked of 101 subjects.

Results: 48 of the pilots reported the experience, ranging from 1 to "several" to all hops. Statistics performed imply that the phenomenon is not related to either: (1) pilot's flight experience (hours flown and altitude) or (2) pilot's expressed emotional towards flight.

86. Curran, P. M. and Wherry, R. J., Fr. Measure of susceptibility to psychological stress. Aerospace Medicine, 1965, 36(10), 929-933.

A confirmatory test of Wherry's model for Anticipatory Physical Threat Stress (APTS). This study tested the effect of experimenter's manipulations of subject's perceived threat in a simulated aircraft mission emergency.

87. Deese, J. Skilled performance and conditions of stress. Revised version, April 1960, of a paper prepared for a symposium on Training research and its implications for education. February 1-3, 1960 at the University of Pittsburgh, sponsored jointly by the University of Pittsburgh and the Office of Naval Research.

88. Finan, J. L, Finan, Sarah C. and Hartson, L. D. A review of representative tests used for the quantitative measurements of behavior-decrement under conditions related to aircraft flight. USAF TR No. 5830, Wright Patterson Air Force Base, Ohio, July 1949. (ATI 65653)

"This report attempts to summarize, correlate and evaluate quantitative tests which have been used to measure psychological performance under a variety of conditions similar to those which are representative of efforts to quantify performance under the following conditions: altitude, vibration, noise, temperature, humidity, fatigue, apprehension, stress, drugs, dietary factors and others."

89. Goldstein, K. Organismic approach to the problem of motivation. Transactions of the New York Academy of Sciences, 1947, 9. 218-230.

90. Gunderson, E. K. E. and Kapfer, E. L. The predictive validity of clinical ratings for an extreme environment. Brit. J. Psychiat., 1966, 112(485), 405-412.

Correlations of clinical ratings of personality traits by psychologists and psychiatrists and performance in the Antartic by over 600 Navy and scientist personnel. Rorschach proved to be non-valid while flexible interview achieved significant validity. "Predictions were most effective when examiners received most information concerning assessment objectives and the Antartic environment."

91. Gunderson, E. K. E. and Nelson, P. D. Biographical predictors of performance in an extreme environment. J. Psychol., 1965, 61, 59-67.

An empirical study of the relationships between biographical predictors and Navy personnel performance in the Anartic. Predictor variables differed based on large-station and small-station groups.

92. Hall, C. S. A primer of Freudian psychology. New York: The New American Library, 1954.

93. Hardy, J. D. Weightlessness and Sub-gravity problems. In J. D. Hardy (Ed.) Physiological problems in space exploration. Springfield, Ill.: Charles C. Thomas, 1964.

"Simulation procedures have great advantages in answering specific questions about a particular system but they suffer from the lack of general applicability of the results. In testing and training astronauts for various space programs it was possible to say with reasonable confidence whether or not the astronaut could control his vehicle under a variety of emergencies. It is thus likely that a wide variety of simulators will be required for setting up as nearly as possible space conditions on the earth and testing and abilities of the man and his machine in the space environment."

94. Harris, W., Mackie, R. R. and Wilson, C. L. Performance under stress: a review and critique of recent studies. ONR Contract No. Nonr 1241 (00). Technical Report No. VI, Human Factors Research, Inc., Los Angeles, California, July 1956.

"Of all the stress and fatigue studies cited, only one finding appears sufficiently consistent to be generalized: Some people are better able to withstand stressful conditions than are others - there are wide variations in individual reactions to stress."

The above comments refers to the findings of a survey of stress reports between the years 1952 and early 1956.

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95. Harris. S. J. The effects of sleep loss on component movements of human motion. J. appl. Psychol., 1960, 44(1), 50-55.

Tests including a control panel, bimanual coordination, leg movement, CFF. and steadiness were given to 19 subjects in a task schedule involving a five-day training period, three-day sleep loss period, and two-day recovery period.

96. Hartman, B. O. MOL: predicting four-hour levels of psychomotor performance from the initial half hour. USAF: School of Aviation Medicine SAM TR 67-55, June 1967.

"Four subjects participated in a MOL-like nutrition study using freeze-dehydrated, bite-sized "Apollo" food. The two experimental subjects were confined in a small (300 cu. ft.) altitude chamber operated at 27,000 feet with an atmosphere of 70% oxygen and 30% helium. Psychomotor testing was conducted in 4-hour sessions three times a day, every other day, alternating with two control subjects. No major psychomotor changes were observed, except on the short-term memory task, which appeared to reflect motivational factors. Correlations between the first half-hour and the remainder of the testing session ranged from -.21 to +.96 and were scattered across that range. It was concluded that a daily half-hour psychomotor test of space crews is probably not sufficient to meet biomedical monitoring requirements."

97. Haythorn, W. W. Small groups observational data in selection. In B. B. Weybrew (Ed.). Personnel selection in the US.Navy: Proceedings of a Navy-wide Workshop, at the Submarine Medical Center, April 1967. Report No. 511, Bureau of Medicine and Surgery, U. S. Naval Submarine Medical Center, Submarine Base, Groton, Conn., February 23, 1968.

Discusses the inadequacy of our knowledge of how to measure behavior, persons, and how to relate the measures. Selection procedures and the logic of assumptions made, particularly with respect to group behavior and performance are discussed. Presents group composition and stress variables to be considered and some pertinent research.

98. Haythorn, W. W. A program of research on isolated groups. Paper presented at the Fifth International Conference on Applied Military Psychology, Oslo, Norway, September 1968.

Discusses in some detail the naval research studies on isolated and stress groups within the context of the overall framework and goals

of naval research program. The concluding statements summarize the goals of the program: "At the very least, the effort will have made explicit the conceptual relevance of the research undertaken to the operational objectives it was undertaken to support. At best, we will have an explicit, concrete model allowing us to derive operationally meaningful predictions of systems performance for alternative manipulations in the personnel subsystem."

99. Haythorn, W. W. and Altman, I. Personality factors in isolated environments. In M. H. Appley and R.Trumbull (Eds.) Psychological stress: issues in research. New York: Appleton-Century-Crofts, 1967, 363-385 and 389-397.

The authors review their own work and that of others as it relates to the interactions between group composition with respect to personality characteristics and stress, especially confinement. Summary comments concerning the nature of the interaction are as follows: "...provide an integrated set of findings which are consistent with the generally hypothesized inverted-U relationship between stress and performance. Of more specific interest are the hypothesized contributions of situational factors, such as isolation, and interpersonal factors of personality composition, to the characteristics of that general curvilinear function...." Variations in group personality composition and a situational factor of social isolation have an effect on group and individual performance effectiveness, but understanding their contribution appears to require an understanding of intervening stress levels they may generate. Mild degrees of stress appear to be associated with enhanced performance, whether they derive from the situation or from group composition characteristics. Combining or adding separate sources of stress does not lead to further performance advantage but is associated with a leveling or impairment of performance effectiveness."

100. Locke, E. A. Interaction of ability and motivation in performance. Perceptual and Motor Skills, 1965, 21(3), 715-718.

Based on four studies, significant relationships are reported between motivation and ability for both low ability and low motivation subjects. Motivation has a greater relative effect on high ability than low ability subjects.

101. McKenzie, R. E. A systems task used in the stress testing of special mission personnel. Human Factors, 1965, 7(6), 585-590.

A specific test set based on two competing tasks one discrete and discontinuous signals and the other a continuous signal input for monitoring and control.

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102. Patton, R. M. Behavioral testing during a 7-day confinement: the information processing task. NASA: TN D 1973, December 1963.

Two subjects, confined for 7 days in a simulated space capsule, were tested for behavioral and physiological effects as a result of confinement. An information processing task of search and detection of letters within an array was used. Effects of confinement duration, time of day, and task complexity were examined.

103. Patton, R. M., and Randle, R. J., Jr. Behavioral testing during a 7-day confinement: the pattern discrimination task. NASA: TN D 1974, December 1963.

A pattern discrimination task requiring sequential pattern judgments was used in a 7-day confinement study with two subjects. Performance is examined as a function of duration of confinement, time of day, on-duty activities, and variations in pattern size.

104. Roman, J. Risk and responsibility as factors affecting heart rate in test pilots. The flight research program-11. Aerospace Medicine, 1965, 36(6), 518-523.

"In 37 flights in a 2-place high-performance aircraft, or 35 hours of instrumented flying time, physical risk or danger did not appear to be a primary causative factor in producing the high heart rates frequently seen in high-performance-vehicle operation. Responsibility for the mission appeared to be a more potent factor. It is recognized that the responsibility factor is not clearly defined and encompasses many variables."

105. Ruff, G. E. Psychological and psychophysiological indices of stress. In N. M. Burns, R. M. Chambers, and E. Hendler (Eds.) Unusual environments and human behavior: Physiological and psychological problems of man in space. Glencoe: The Free Press, 1963, 33-59.

A review of the measures of stressor effects with both psychological and psychophysiological dimensions. Topics covered under psychological measures include: (1) perceptual tests, (2) motor tests, (3) perceptual-motor tests, (4) cognitive tests, and (5) tests of emotional response.

106. Seminara, J. L., Shavelson, R. J. and Parsons, S. O. Effects of reduced pressure on human performance. Human Factors, 1967, 9(5), 409-418.

I. D. Individual Measurement: Stressors and Stress Responses

Simulation study of the effect of reduced pressure (1.5 psi) as compared with ambient pressure (14.7 psi) on performance with three kinds of tasks: psychomotor, a lunar mission-specific task, and walking.

107. Shavelson, R. J. Lunar gravity simulation and its effect on human performance. Human Factors, 1968, 10(4), 393-402.

A critical review of the simulation literature on the effect of lunar gravity on performance suggests deficiencies in present techniques of simulation for this area.

108. Shavelson, R. J., and Seminara, J. L. Effects of lunar gravity on man's performance of basic maintenance tasks. J. appl. Psychol., 1968, 52(3), 177-183.

An interaction study of performance obtained by nine subjects performing three maintenance tasks, in three clothing conditions, under three gravity conditions. Substantial performance decrement was obtained as a function of clothing conditions and gravity.

109. Sheldon, W. (with the collaboration of S. S. Stevens). The varieties of temperament. New York: Harper, 1942.

110. Smith, S. Studies of small groups in confinement. In J. P. Zubek (Ed.) Sensory deprivation: fifteen years of research. New York: Appleton-Century-Crofts, 1967.

A wide ranging survey of small groups in confinement, including a good sampling of what is known of operational groups under long term confinement.

111. Smith, S., Murphy, D. B., Hampton, G. L., Bernardo, R. and Burdick, H. Comparison of random pairs and real pairs on a simple auditory counting tasks. Research Memorandum, U. S. Army Leadership Human Research Unit, Presidio of Monterey, California, March 1963. (AD 638 306)

This study is another indication that interaction effects may cancel out any advantages of working in groups when the task can be performed independently.

I. D. Individual Measurement: Stressors and Stress Responses

112. Teichner, W. H. Response blocking: a necessary performance criterion. Paper presented to American Assn. for Automotive Medicine, Sacramento, California in October 1968. Guggenheim Center for Aerospace Health and Safety, Harvard School of Public Health.

Conclusions about response blocking drawn from experimental results:
1. Occur periodically with a duration of about 2-6 responses. Frequency and length of blocking directly proportional to task complexity and rate of information flow.
2. Reaction times increase sharply beginning about 4 to 5 responses before a block and decrease sharply immediately after the block.
3. Frequency and size of response blocks apparently increases with the " fatigue" of prolonged performance and as a result of environment conditions.
4. Sleep loss causes a sharp increase in response blocking.
5. Can occur as an emotional reaction to emergencies or as a conflict reaction to decision-making situations.

Paper suggests that this performance criterion is subject to individual differences.

Examples of use given: probability of visual signal detection after different periods of searching for a signal whose location and time of occurance is uncertain is represented as a function of environmental stressors (CO content), response blocking, and length of time at the task.

113. Trumbull, R. Environment modification for human performance. USN: ONR Report ACR-105, 29 July 1965.

An examination of the three essential environments of human performance: physical, social and cultural, and personal as they pertain to task behavior. Relevant research in all three areas is extensively reviewed and related.

114. Trumbull, R. Diurnal cycles and work-rest scheduling in unusual environments. Human Factors, 1966, 8(5), 385-398.

An extensive review of the literature on psychological and physiological effects and their interrelationships with various work-rest cycles as related to diurnal cycles.

115. Ugelow, A. Motivation and the automation of training: A literature review. USAF: MRL-TDR-62-15, March 1962.

An analysis of the learner motivation problem in the use of automated teaching devices. "Controlling the motivation of learners in their continuing use of the new auto-instructional devices could become a serious problem, since neither the devices themselves nor the performance knowledge they provide seems sufficient to maintain extended participation in the instruction. A selective review of the literature on knowledge of results, praise and reproof, competition, task interruption, and readability suggests techniques for better controlling such participation."

116. Weybrew, B. B. Patterns of psychophysiological response to military stress. In M. H. Appley and R. Trumbull (Eds.) Psychological stress: issues in research. New York: Appleton-Century-Crofts, 1967, 324-353.

The author summarizes what is known from experimental and operational studies of stress in the aerospace, terrestrial-marine, and submarine environments about man's psychophysiological response to it and possible selection criteria. A series of comments of particular interest are the following: "...although individual differences are significant, all pilots experience anxiety before and after combat missions...anxiety proneness is related to two basic factors: (1) the lability or susceptibility to emotional arousal and (2) control or ability to function under emotion-evoking circumstances... strong supporting evidence from the aviation literature...to indicate the important relationship between stress tolerance and motivational variables, in particular what they call ego-involvement."

117. Wilson, C. L. (Ed.) Project Mercury candidate evaluation program. WADC Technical Report 59-505, Aerospace Medical Laboratory, Wright Air Development Center, Air Research and Development Command, USAF, Wright-Patterson AFB, Ohio, December 1959. (AD 234-749)

Thirty one highly selected adult males were the subjects of a Mercury candidate recommendation study. 104 performance variables (Variables included were: psychological, acceleration stress, anthropometric, biological acoustical, heat variables, physical fitness and medical measures) were correlated. The mean test results of the subjects not recommended were compared with the mean test performances of the subjects who were recommended. Only two of the variables were different, significant at the .01 level: over-all psychological rating and performance on the Digit Span subtest of the WAIS. Of the 31 candidates, 8 were not recommended, 3 were rated outstanding with reservations, 7 were rated outstanding, and 13 were highly recommended. The following statements represent some of the preliminary impressions

of the investigators responsible for the Project Mercury Candidate Evaluation Program. (direct quotes from p. 99) (except for numbers)

1. It is possible to eliminate subjects by use of stressful tests. It is not presently possible to select subjects with confidence, where selection is based entirely upon their excellent physiological performances.

2. No single, nonsimulating test has been identified which will be of great assistance in recommending crew members. A large battery of tests, such as were performed, lends confidence to the final recommendations.

3. This study has demonstrated that there is no statistically significant difference in the physiological or biochemical responses of the Mercury Astronauts when compared with the remainder of the NASA candidates.

4. There is every reason to suspect that safe, standardized, moderately stressful and severely stressful tests (such as having the subject walk on the treadmill until he voluntarily terminates) would be of great assistance in future crew recommendation programs, since severe stress also tests the candidate's motivation.

118. Wing, J. F. A review of the effects of high ambient temperature on mental performance. USAF: AMRL TR 65 102, September 1965.

An analysis of 15 experiments on the effect of high thermal stress on performance. The thermal performance limit varies with duration of exposure to temperature levels. Performance decrement appears well before physiological tolerance limits are reached. "The upper limit for unimpaired mental performance should not be generalized to all stages of practice, to all degrees of temperature acclimitization, to all types of tasks, or to all subject populations."

I. E. Small Group Measurement

119. Haythorn, W. W. The composition of groups: a review of the literature. Acta Psychologica, 1968, 28, 97-128.

"This literature survey finds that research supports the view that group composition significantly determines group member behavior; that both homogeneity and complementarity hypotheses regarding the bases of compatibility and group effectiveness are tenable; that greater specificity is required in describing composition relationships and criteria; and that classifying dyadic relationships between personality variables as congruent or incongruent, complementary or not seems to add a useful degree of precision." (Author's abstract)

This is a comprehensive review which presents most of the available information on group analysis and the compositional variables which have been related to group effectiveness.

120. Heslin, R. Predicting group task effectiveness from member characteristics. Psychological Bulletin. 1964, 62, 248-256.

Author suggests group behavior prediction in terms of:

a. Relevant individual personality dimensions
b. Group social dimensions
c. Task and situational dimensions.

121. Prien, E. P. Dynamic character of criteria: organization change. J. appl. Psychol., 1966, 50(6), 501-504.

Discussed the difficulties in criterion development and measurement based on dynamic individual and organizational variables, given that the job task itself does not change.

122. Shaw, E. Scaling group tasks: a method for dimensional analysis. Office of Naval Research Contract NR 170-266, Nonr-580(11), Technical Report No. 1. University of Florida, Gainesville, Florida, July 1963. (AD 415 033)

Method: On an a priori basis, 10 task dimensions were selected* and were used to scale 104 group tasks (the tasks are described in the appendix). The tasks were scaled on the ten dimensions by 49

* Cooperation requirements, decision verifiability, difficulty, goal path multiplicity, intellectual-manipulative requirements, intrinsic interest, operational requirements, population familiarity, solution multiplicity.

judges and the data was factor analyzed. To clarify the findings of the first factor analysis, a second analysis was performed on the more reliable data.** The article gives a complete description of the scaling procedures used on the tasks.

Results: Five factors resulted from the factor analysis, four of which were easily identified. The fifth one loaded heavily on two dimensions. Intellectual-manipulative requirements and Population familiarity. The author felt that this was caused by the use of graduate students and group research workers as judges and, therefore, that these were actually independent factors. The four factors were Cooperation Requirements, Difficulty, Solution Multiplicity and Intrinsic Interest. The other four dimensions which did not define unique factors loaded primarily on Difficulty and Solution Multiplicity.

123. Shaw, M. E. Social psychology and group processes. In J. B. Sidowski (Ed.) Experimental methods and instrumentation in psychology. New York: McGraw-Hill, 1966, 607-644.

A comprehensive review of group research and the experimental methods which have been used is presented.

124. Voiers, W. D. Bombing accuracy as a function of the ground-school proficiency structure of the B-29 bomb team. Research Report AFPTRC-TN-56-4, A. F. Personnel and Training Research Center, Lackland Air Force Base, Texas, 1956.

An exploratory study using gross individual proficiency and group bombing performance measures indicated the relationship between individual proficiencies and group performance was a function of whether individuals performed tasks in series or in parallel. The group output seemed to be a function of either the weakest or the most critical link (e.g., final) when the tasks were in series, and a function of the better performers when the tasks were in parallel.

** The dimension Goal clarity was dropped as it appeared to be unreliably scored.

I. F. Test Battery Development

125. Cronbach, L. J., and Gleser, G. C. Psychological tests and personnel decisions. Urbana, Ill.: University of Illinois Press, 1965. (Second Edition).

A major theoretical contribution to modern test theory presenting in detail and formally the utility concept as applied to test selection, construction, and use.

126. Guilford, J. P. Psychometric Methods. Second Edition. New York: McGraw-Hill, 1954.

Psychometric theory and the measurement and statistical operations are discussed clearly and in detail. The chapter titles are as follows: Psychological measurement, Psychophysical theory, A mathematical introduction, The method of average error, Method of minimal changes, The constant methods, The method of pair comparisons, The method of rank order, Scaling from interval and ratio judgments, The method of successive categories and other scaling methods and problems, Rating scales, Principles of judgment, Theory of psychological tests, Reliability and validity of measures, Test development, and Factor analysis.

VOLUME III

II. TESTS: DESCRIPTIONS, DATA, AND APPLICATIONS

A. GROSS BODY MOVEMENT DIMENSIONS

B. COGNITIVE, PERCEPTUAL, PSYCHOMOTOR, AND MEMORY DIMENSIONS

C. PERSONALITY AND INTERACTION DIMENSIONS

D. VISION

E. MISCELLANEOUS

F. PERFORMANCE PANELS

G. SIMULATION

II. A. Tests, Gross Body Movement dimensions

127. Balke, B. Human Tolerances. Federal Aviation Agency, Aeronautical Center, Civil Aeromedical Research Institute, Oklahoma City, Oklahoma, April 1962. (N62-12018)

HUMAN TOLERANCES and PHYSICAL FITNESS

The report discusses some human tolerance limits which would interact with aerospace activities. Overviews are given on the following topics along with some specific tolerance data: psycho-physiological stress, gravitational forces, hyperventilation, high altitudes, decompression sickness, hypercapnia (CO_2 concentration), temperature extremes, and physical work.

Physical Fitness: two limitations are considered, functional and metabolic. With respect to the functional limitations, the author comments: "Both the circulatory as well as the respiratory limitations can be expressed in one single criterion: the maximum oxygen intake. Whenever at further increasing work intensities oxygen consumption reaches a constant level, the functional adaptability is outdone. For ...evaluation of physical fitness, many individual's maximum oxygen intake, expressed in ml/min/kg, means a certain place on the functional fitness scale." (p 12) Metabolic limitations are discussed as follows: "The metabolic limitations of work capacity can be assessed during strenuous but submaximal work of longer durations. The body's glycogen stores are usually running low after close to two hours of strenuous physical activity. Fat depots are also utilized for energy supply as long as carbohydrates are available in sufficient amounts. An exhaustion of carbohydrates terminates the capacity for further physical work." Carbohydrate reserves range from 100 grams to 400 grams respectively for poor to very good physical condition. "The latter (400 g) cannot only work at a much higher rate and for a longer period than the former because of the higher glycogen stores but also because of the ability, probably "learned" in training, to utilize to a greater extent the body fat as an energy source" (p 12).

The author discusses the interaction of the functional and metabolic limitations with the stresses of heat, cold and altitude. Summary statements are given below.
Heat: Heat imposes a stress upon the circulatory system, requiring the total blood flow to be divided between the body surface (for cooling) and the body musculature (for oxygen). The following comments were made: "...the effects of high temperatures (not extreme) have caused reductions of work capacity by 25 percent and more. ...there are not many reserves left at extremely high temperatures and the

slightest additional stress, requiring further circulatory adaptations, might complicate the situation beyond possible physiological solutions." (p 13)

Altitude: "An astronaut, having an identical level of altitude acclimatization, should be able to perform work of 2-3 times his basal metabolic rate under environmental conditions equivalent to 50,000 feet-when breathing oxygen" (p 14). ("acclimatization" here refers to the mountaineers climbing Mt. Everest.)

Cold: Functional limitations are not directly involved in capacity for work in severe cold. However, the metabolic work capacity is considerably reduced when severe shivering occurs prior to work or during work breaks. Once the carbohydrate stores are exhausted, a fatality is entirely possible.

128. Buros, Ed. The Fourth Mental Measurements Yearbook. Highland Park, N. J.: Gryphon Press, 1953.

THE RAIL-WALKING TEST

Data: Norms on 1013 Army men available in Am J Psychol, 1944 57, 482-499. Norms on school children ages 6-14, available from author. Distribution is not normal, with poor differentiation at upper end of scale (reviewer comment)

Cost: Test apparatus must be constructed and consists of 3 wooden rails: 9'x4", 9'x2", and 6'x1". Individual administration, 5 minutes.

Description: Specifications for making rails and directions for administration, scoring and interpretation are presented in the above reference.

Measures: Locomotor coordination and general motor control. Reviewer comments that two studies found a .65 correlation with MA and a negligible correlation with CA.

129. Buros, O. K. The Sixth Mental Measurements Yearbook. Highland Park, N. J.: Gryphon Press, 1965.

II. A. Tests, Gross Body Movement dimensions

AAPHER YOUTH FITNESS TEST

Age: 10-17, college men

Cost: largely indiv.; 5-15 min per student or 100 min in 2 sessions for group of 35 w/no swimming; revised manual (75¢); record form, 4pgs, (75¢/25); college norms supplement, 4pgs ($1/25); personal fitness record, 4pgs (5¢/1); cumulative fitness record, 4pgs ($2/25); fitness test dial for boys, age 10-17 ($1), Softball (?)

Data: No data on reliability or validity, no swimming norms, norms for ages 10-17 (fitness test dial for percentile ranks), norms for college age (supplement)

Description: test items: gynamic pull-ups, explosive and dynamic sit-ups, explosive 40yd run retrieving objects, explosive broad jump, explosive 50yd dash, explosive softball throw, 600yd run-walk, optional swimming (no norms).

Measures: fitness
Based on Fleishman's (1964) work the test measures: dynamic strength, explosive strength and stamina.

BASIC FITNESS TEST

Tested: flexibility - extent and dynamic
strength - explosive, static, dynamic, trunk,
coordination
equilibrium
stamina

Ages 12-18, 11 scores, process 50 students in 2 hrs.

Cost: $1.95/manual, 10¢/4pg performance record

Data: Reliability on test-retest is .70 to .93
Validity, factor analytic: .47 to .81

130. Fine, B. J. Personality traits as related symptomatology and running performance at altitude under normal and drug (Acetazoleamide) conditions. Perceptual and Motor Skills, 1968, 27, 975-990.

II. A. Tests, Gross Body Movement dimensions

PERFORMANCE CHANGES UNDER STRESS

Subjects: 45 Special Forces soldiers ranging in age from 21 to 44 years. Data analysis generally based on smaller number, however.

Method: two personality tests were administered: MMPI and the 16 Personality-Factor Test. Two performance measures, Fleishman's 600-yd Run-Walk and Shuttle Run, were administered at sea level and on each of five days at a 13,000 ft., relatively cold and isolated, altitude. Half of the subjects received placebos, while the other half received Acetazoleamide, a mountain sickness drug.

Results: the analysis indicated that the effects of altitude and especially the drug, as measured by performance decrement, were related to the personality test measures. The pattern of correlations indicates a complex dose-response relationship which needs further exploration. The Shuttle Run performance decrements for the placebo group did not correlate significantly with the personality measures. The 600-yd Run-Walk decrements for the placebo group did, however, correlate significantly with two of the personality measures: -.40 ($p<.10$) with MF of the MMPI and -.49 ($p<.05$) with F of the PF Test.

131. Fleishman, E. A. The Structure and Measurement of Physical Fitness. Englewood Cliffs, N.J.: Prentice-Hall, 1964.

PHYSICAL FITNESS TESTS

The history of physical fitness testing is summarized. The author's experimental research to derive the factorial structure of physical fitness is discussed in detail. Two basic studies were performed using the tests which are described below:

Speed, flexibility, balance, and coordination test analysis. 204 Naval recruits, 18-19 years old, were used. Administration time for a 30 test battery to 60 men was about 2 hours.

Strength test analysis. 201 Naval recruits, 18-19 years old, were used. The test battery was administered over three sessions of $2\frac{1}{2}$ hours per subject, 1 session per day.

Further studies were conducted with a subset of the experimental tests to establish norms and reliability figures. The Basic Fitness Tests were taken from this set.

II. A. Tests, Gross Body Movement dimensions

ABDOMINAL STRETCH

Description: The subject stood with the front of his body against a fence. A strap was placed around the subject's buttocks and attached to the fence so that his hips were held firmly against the fence. The subject then leaned backwards as far as possible. His score was the horizontal distance from the fence to the subject's chin.

Measures: Factor loading of: .55 on extent flexibility

ARM CIRCLING

Description: This test proposed to measure the speed with which the subject could circumduct his arm. The subject, while standing, leaned over a waste basket and, using his preferred hand, swung his arm so that his hand went completely around the circumference of the waste. The hand was kept below the top of the basket throughout the test. The subject's score was the number of revolutions made in 20 seconds.

Measures: Factor loadings of: .52 on explosive strength
.39 on speed of limb movement

ARM PULL - DYNAMOMETER

Description: The position in which this test was given was subject standing with one hand on the pole and the other hand in the dynamometer. Special springs (to allow measurements up to 450 lbs) were inserted in the grip strength dynamometer and the whole assembly inserted into the adapterhandles. One handle was attached by a strap to a pole/the subject gripped the other handle (with his strongest arm) while bracing himself against the pole with his free arm. When the signal "pull" was given, the subject pulled on the dynamometer handle as hard as he could. The forearm and legs had to be kept straight. The straps were adjusted for each subject's arm length. The subject made three such "pulls" with a minimum of 30 seconds between trials. Score was the best of his three pulls.

Data: Test-retest reliability of .83.

Measures: Factor loading of: .71 on Static Strength.

II. A. Test, Gross Body Movement dimensions

BALANCE-A TEST (Also called One Foot Lengthwise Balance-Eyes Closed)
Data: Test-retest reliability is .82.

BALL BALANCE
Description: The subject, keeping his feet stationary, balanced a volley ball on the back of the closed fist of his preferred hand, holding his arm at shoulder height. The subject determined his starting time by saying "Go," when he felt he had the ball under control. His time ended when he let the ball touch any other part of his body, when the ball fell to the floor, or when he moved either foot. The ball had to be kept on the back of the fist and was not allowed to touch the wrist or arm. The wrist was held straight and was not allowed to bend to help support the ball. His score was the length of time he balanced the ball.

Measures: Factor loading of: .47 on speed of limb movement

BASIC FITNESS TESTS
Description: A set of 10 tests which are described in detail under the specific test titles: Extent Flexibility (same as Twist and Touch), Dynamic Flexibility (same as Bend, Twist and Touch), Shuttle Run-Timed, Softball Throw, Hand Grip, Pull-Ups-to limit, Leg Lifts-Time limit, Cable Jump, Balance A (same as One Foot Lengthwise - Eyes closed), and 600 yard Run-Walk.

Data: the student norms, Naval test subject means and test-retest reliabilities are given.

BEND, TWIST, and TOUCH (Also called Dynamic Flexibility)
Description: This test proposed to measure the speed with which the subject could flex, extend and rotate his spine. The subject stood with his back to the wall with his feet a shoulder width apart. An "X" was placed on the wall in chalk or tape directly behind the middle of the subject's feet. On the signal "Go," the subject bent forward and touched the X between his feet with both hands and then straightened up and touched the X on the wall with both hands. This represented one cycle. The next cycle was the same except that the subject twisted to his right and continued to alternate the side to which he twisted in each successive cycle. The subject's score was the number of cycles completed in 20 seconds.

II. A. Tests, Gross Body Movement dimensions

Data: Test-retest reliability of .92

Measures: Factor loading of: .50 on dynamic flexibility.

BENT ARM HAND - TIMED

Description: After a demonstration, the subject pulled himself up to the chinning bar until his eyebrows were "level" with the middle of the bar. The subject was required to keep this position as long as he was able to. The subject was not allowed to touch any part of his head to the bar nor to kick or struggle or move his body. An eye-level observer allowed no more than one inch deviation in "eyebrow" position. Palms faced away from the body. Special efforts were made to keep the subjects in position, especially as they began to tire. The bar used was 1 3/4" in diameter and was 6 feet 8 inches above the ground. Score was the number of seconds in the proper position from the signal "go".

Measures: Factor loading of: .73 on Dynamic strength.

BLOCK TRANSFER

Description: Two trays, 12 inches, square, $9\frac{1}{2}$ inches deep were placed on the table so that one tray was 6 inches beyond the first tray in front of the subject. Twelve one inch cube blocks were in the tray nearest the subject. On the signal "Go," the subject, using his preferred hand, transferred all the blocks from the front tray to the far tray, taking only one block at a time. The subject then transferred the blocks back to the near tray, and then repeated this procedure to the far tray so the blocks had been transferred three times, ending up in the far tray. The subject's score was the number of seconds required to complete the three transfers.

Measures: Factor loading of: .56 on dynamic flexibility.

BOARD BALANCE

Description: This test proposed to measure the ability of the subject to maintain his balance while standing on a movable support. A teeter board was constructed of a board, 24 inches x 12 inches x 1 inch, supported in the middle by a board, 12 inches x 2 inches x 4 inches. The bottom of this 12x2x4 center board had the edges planed off at an angle so that the width of surface in contact with the floor was only one inch. The subject balanced himself on the teeter board by placing one hand on the tester's shoulder for support. When the subject felt he had his balance and wanted to start,

he removed his hand from the tester's shoulder. This was the signal for the tester to start the stop watch. The subject's score was the length of time he maintained his balance. His balance was lost when he fell off the board, or when either end of the teeter board touched the floor.

Measures: Factor loadings of: .27 on gross body equilibrium
.30 on dynamic flexibility
.29 on balance-visual cues

CABLE JUMP TEST

Description: a 24 inch rope length is held loosely by the subject in front of himself. The S is required to jump over the rope without loosening his grip of it. Score is the number of correct jumps out of five attempts.

Data: test-retest reliability is .70

Measures: Factor loading on Gross Body Coordination is .56

CIRCLE RUN

Description: A circle 12 feet in diameter was made on the floor. A starting point was marked on the circumference of the circle. On the signal "Go," the subject ran clockwise around the outside of the circle. The subject's score was the length of time required to complete five rounds.

Measures: Factor loading of: .59 on explosive strength

DEEP KNEE BENDS - TIME LIMIT

Description: The subject started in an upright position. At the starting signal he lowered himself to a full squat (trying to touch his heels), and then returned to the upright position. To keep his balance he was advised to fix his eyes on a given point and he was allowed to extend his arms. (Under this speeded condition too many lose their balance in the "hands on hip" position). The subject tried to do as many such deep knee bends as possible in 30 seconds. Score was the number of times he returned to the starting position in 30 seconds.

Data: Test-retest reliability of .85.

Measures: Factor loadings of: .25 on Dynamic strength
.25 on Explosive strength
.25 on Weight Balance

II. A. Tests, Gross Body Movement dimensions

DIPS - TIME LIMIT

Description: Subject supported himself between parallel bars (Medart Co., 5'2" high, 25" separation at center) with his arms stiff. At the signal "start", he lowered himself until there was a 90° angle between his forearm and upper arm, with his upper arms parallel to the floor. He was cautioned that lowering past this position would make it much harder for him to raise himself again, and he was required to raise himself all the way up to the start position to complete a cycle. After the demonstration, the subject was required to go as fast as possible for 10 seconds. (This was found to be too long, as these subjects found this exercise a very tiring one). Score was the number of times the subject returned to the start position in 10 seconds.

Data: Test-retest reliability of .92

Measures: Factor loadings of: .70 on Dynamic strength
.33 on Explosive strength

DIPS - TO LIMIT

Description: Same as Dips-Time Limit Test except the subject was instructed to continue to do as many dips as he could. He was told not to stop in the up or down position for more than three seconds. If he started to sway excessively, the observer placed his palm against his legs to stop the swaying. Score was the total number of times the subject returned to the starting position without stopping for 3 seconds at any point.

Data: Test-retest reliability of .91.

Measures: Factor loadings of: .63 on Dynamic strength
.27 on Explosive strength
-.30 on Athletic experience Specific

DODGE RUN

Description: Six chairs are set up in a pattern. On the signal "Go," the subject ran around the chairs in a particular path. Upon arriving at chair number six the subject did not go back to the starting line, but went directly around chair number one again and repeated the path around all of the chairs. When he arrived at chair six the second time, he went directly to the starting line. The subject's score was the length of time required to make the two trips and return to the starting line.

Measures: Factor loading of: .69 on Explosive strength

II. A. Tests, Gross Body Movement dimensions

FIFTY YARD DASH - TIMED

Description: Same as 10 yard dash, except for the distance. Score was time (to nearest tenth of a second) for one dash.

Test-retest reliability of .86

Measure: Factor loadings of: .44 on Dynamic strength
.75 on Explosive strength

FIGURE-8 DUCK

Description: Two uprights were placed 10 feet apart with the cross bar adjusted to the height of the subject's waist. The subject started at the right of one of the uprights. On the signal "Go," he ran under the cross bar, went around the far upright, back under the cross bar again, and around the near upright. In other words, the subject ran around the uprights in a figure-8 fashion, ducking under the cross bar each time. This completed one cycle. The subject's score was the length of time required to complete four cycles.

Measures: Factor loading of: .68 on Explosive strength

GRASS DRILL

Description: Two chairs were placed seven feet apart. The subject got down on all fours, hands and feet, beside one of the chairs. On the signal "Go," the subject, on all fours, travelled around the first chair, between the chairs, around the second chair, and back between the chairs to his starting point, thus completing the figure-8. This completed one cycle. The subject's score was the length of time required to complete four cycles.

Measures: Factor loading of: .62 on Explosive strength

HAND GRIP

Description: A Narrangansett Co. grip dynamometer, calibrated from 0-200 lbs was used. The subject used the hand he thought strongest. The dynamometer was placed in his palm, dial up, gers curled over so that part of the fingers between the second and third knuckles were touching the grip. The subject held his arm down at his side, away from his body. He was not allowed to rest his forearm against his body. At the command "squeeze", he was told to squeeze the dynamometer once, sharply, as hard as possible. He was given three "squeezes", with at least 30 seconds between trials. Score was the best of his three squeezes.

II. A. Tests, Gross Body Movement dimensions

Data: Test-retest reliability of .85.

Measures: Factor loading of: .68 on Dynamic strength

HOLD HALF SIT-UP - TIMED

Description: The subject lay on the floor. His partner straddled his legs with his hands on the subject's knees. The subject's hands were behind his neck, elbows spread, but his hands did not touch the back of his neck, to avoid additional support being furnished. On the signal "start," the subject sat up until the upper half of his body was half-way to a sitting-up position as long as he possibly could. Emphasis was placed on keeping the body rigid, with chest out, stomach in. Discrepancies were corrected and every effort was made to keep the subjects trying. Score was the number of seconds subject remained in position.

Data: Test-retest reliability of .88.

Measures: Factor loadings of: .30 on Dynamic strength
.45 on Trunk strength

LATERAL BEND

Description: The subject stood upright between two standards, arms straight and to his side with fingers pointed down. The tap plates were adjusted to 4 inches below the subject's fingertips. On the signal "Go," the subject bent to the right and touched the tap plate, then without twisting and with knees kept straight, he bent to the left and touched the plate on the left side. The lateral bending was done with knees and hips locked, shoulders back and head up. This completed one cycle. The subject's score was the number of cycles completed in 20 seconds.

Measures: Factor loading of: .58 on Dynamic flexibility.

LEG CIRCLING

Description: The subject stood in such a way that he could swing his preferred leg around the circumference of a waste basket in a clockwise direction. He used the back of two chairs for support, and kept his foot below the level of the waste basket throughout the test. The subject's score was the number of revolutions completed in 15 seconds.

II. A. Tests, Gross Body Movement dimensions

Measures: Factor loadings of: .27 on Explosive strength
.48 on Dynamic strength

LEG LIFTS - TIME LIMIT

Description: The subject lay flat on his back, hands behind his neck, with his elbows held to the floor by a partner; he then raised his legs until they were vertical, and then returned them to the floor. He was told to do as many of these lifts as he could do in 20 seconds, after the signal "go". He was required to keep the small of his back and the base of his spine on the floor. Effort to boost the body or to rock were not allowed. A stiff one-two motion was used with the legs straight at all times. A demonstration was given and the subject tried the movement twice before the actual test. Score was the number of times the legs were elevated to a vertical position in the 20 seconds.

Data: Test-retest reliability was .84.

Measures: Factor loadings of: .32 on Dynamic strength
.47 on Trunk strength

LEG RAISER - TIMED

Description: Subject lay flat on his back, hands clasped behind neck. At the signal "go", he raised his heels until they were 14 to 16 inches off the floor and held them there, legs straight, as long as he could. To emphasize trunk muscles, the back of his head, small his back, and elbows had to touch the floor at all times (partner held his elbows down). An observer kept a pencil under the subject's legs to make sure he did not drop his legs below 14 inches. Defects in position were corrected immediately by the observer. Examiners made special efforts to keep the subjects from giving up by exhorting them to continue at every sign of let-down. Score was the number of seconds, from "go", that the subject kept his legs in the air.

Data: Test-retest reliability of .71.

Measures: Factor loadings of: .35 on Dynamic strength
.43 on Trunk strength

MEDICINE BALL PUT - SITTING

Description: The subject sat so his outstretched arms were even with a base line. The 9 lb. medicine ball was marked on each side with adhesive tape. The subject grasped the ball with his palms on each side of the ball at the tape. His hands were not allowed behind the ball, and he was not to cock his wrists. The ball was brought back to the chest and pushed out from the body as far as

possible. To further emphasize the arms, he was not allowed to move from his sitting position while putting the ball. He was given three trials. Score was the distance the ball was propelled in the best trial.

Data: Test-retest reliability of .73.

Measures: Factor loading of: .44 on Static strength.

MEDICINE BALL PUT - STANDING

Description: The medicine ball used weighed 9 pounds. The subject held the ball in his preferred hand and balanced it with his other hand. He placed his forward foot on the back of a base line and positioned his other foot in a comfortable position. Once in place he was not permitted to move his feet although he could twist his body. This was to emphasize the arm-shoulder involvement and to minimize the leg contributions. The subject was to throw the ball as far as possible with the one hand. He was allowed three correct throws. Score was the distance, in feet, of the best throw.

Data: Test-retest reliability of .70.

Measures: Factor loading of: .71 on Static strength.

ONE FOOT CROSS BALANCE - EYES CLOSED

Description: This was the same as One Foot Cross Balance-Eyes Open except the eyes were kept closed throughout.

Measures: Factor loading of: .54 on Gross Body equilibrium

ONE FOOT CROSS BALANCE - EYES OPEN

Description: This was similar to One Foot Lengthwise Balance-Eyes Open except that the subject balanced on the ball of the preferred foot with the long axis of the foot. Particular attention had to be given to the balancing foot since it was easy to let the heel or toe touch the floor unintentionally.

Measures: Factor loadings of: .38 on Gross Body Equilibrium
.55 on Balance Visual Cues

ONE FOOT LENGTHWISE BALANCE - EYES CLOSED (Also called Balance A Test)

Description: This was the same as One Foot Lengthwise Balance-Eyes Open except that the eyes were kept closed throughout, except for practice trial.

Measures: Factor loading of: .72 on Gross Body Equilibrium

II. A. Tests, Gross Body Movement dimensions

ONE FOOT LENGTHWISE BALANCE - EYES OPEN

Description: A wood balance rail 1½ inches high, 3/4 inch wide, and 24 inches long was fastened to a board. The subject balanced on the rail, with his hands on his hips, using the preferred foot with the long axis of the rail parallel to the long axis of his foot. The subject determined the starting signal, when he felt he had his balance he said "Go," and the tester started a stop watch. The time ended when the subject touched the floor with any part of his body, or when he removed either hand from his hips. The subject's score was the length of time he held his balance.

Measures: Factor loading of: .64 on balance-visual cues

ONE FOOT TAPPING

Description: The subject sat on a chair, placing his preferred foot next to a board 18 inches long. A 6 inch perpendicular partition was in the center of the board. On the signal "Go," the subject lifted his foot over the partition and tapped the board on the other side. Then, he immediately lifted and returned his foot over the partition and tapped the board on the starting side. This was counted as one cycle. The subject's score was the number of cycles completed in 20 seconds.

Measures: Factor loading of: .58 on Dynamic flexibility

PLATE TAPPING

Description: The subject sat facing two 8 inch discs fastened to a board so that the distance between the discs was 24 inches. On the signal "Go," the subject, using his preferred hand, tapped the plate on his right, then immediately tapped the left plate. This was counted as one cycle. The subject's score was the number of cycles completed in 20 seconds.

Measures: Factor loadings of: .39 on Explosive strength
.44 on Speed of Limb Movement

PULL-UPS -- TO LIMIT

Description: At the start, the subject hung from the bar with palms facing toward the body. At the "start" signal, he pulled himself down until his arms were fully extended to complete the cycle. The subject was told to continue until unable to do any more. He was cautioned against kicking and twisting, or stopping in any one position for more than two seconds. Excessive swaying was stopped. The examiner counted aloud and if the subject's arms were not fully extended, or if the chin did not reach the bar, he counted "one-half" instead of "one". The bar used was 1 3/4 " in diameter and was 7 feet 10 inches off the ground. Score was the

number of chins completed.

Data: Test-retest reliability of .93.

Measures: Factor loadings of: .81 on Dynamic strength
.29 on Explosive strength

PULL-UPS - TIME LIMIT

Description: Same as the Pull-Ups To Limit except the subject was told to chin as fast and as many times as possible in 20 seconds. Score was number of complete chins in 20 seconds.

Data: Test-retest reliability of .95.

Measures: Factor loadings of: .78 on Dynamic strength
.40 on Explosive strength

PULL WEIGHTS, ARMS - TIME LIMIT

Description: The subject lay face down on a bench four feet high, 6 feet long, and 1 foot wide. He was handed a barbell under the bench, which he gripped with palms facing down. He then pulled the bar up to the bench under him. His hands were spaced so that his forearms were perpendicular to the floor, in this position. After two "familiarization" cycles, the arms were returned to the extended downward starting position. At the signals "ready" and "start", he was required to pull the bar up, until it touched the underside of the bench, and then to lower it to a fully extended position as many times as possible in 20 seconds. The subject was cautioned to use a smooth motion, not to bounce the bar off the bench, not to jerk his shoulders or any other part of his body off the bench. To place further emphasis on the arms, his partner held the subject's lower legs down. A cushioning towel was placed under his head and a second observer held the subject's head lightly by placing one hand on each side of his head. The weight of the bar was 17 plus added weights of 20 lbs. This 37 lbs was found liftable enough for the emphasis on speed. Score was the number of times the subject returned the barbell to the start (extended) position in 20 seconds.

Data: Test-retest reliability of .80.

Measures: Factor loadings of: .33 on Static strength
.50 on Weight Balance

II. A. Tests, Gross Body Movement dimensions

PUSH-UPS - TIME LIMIT

Description: The subject was told to do as many push-ups as possible in 15 seconds. In a prone position, his hands were beside the chest, fingers pointed forward. His hands were placed far enough apart so that the forearms made a right angle with the floor. Feet were together, body straight, and only chin and chest allowed to touch the floor. The body was raised until the arms were stiff, and the back was not to be arched. Score was the number of push-ups in 15 seconds.

Data: Test-retest reliability of .76.

Measures: Factor loading of: .68 on Dynamic strength.

PUSH-UPS - TO LIMIT

Description: Same as Push-Ups - Time Limit, except the subject was instructed to continue as long as possible. He was cautioned against remaining in any one position more than two seconds. Score was the total number of push-ups completed.

Data: Test-retest reliability of .88.

Measures: Factor loading of .74 on Dynamic strength.

PUSH WEIGHTS, ARMS - TIME LIMIT

Description: The subject lay face up on the bench with his feet flat on the floor. He was handed the 37 lb. barbell, with his palms facing his feet. With the barbell close to his chest, the hands were spaced just wide enough so his forearms were perpendicular to the floor in this position. He pressed the barbell twice to familiarize himself with proper movement. In the "start" position. Speed was emphasized. He was cautioned not to bounce the bar off the chest and to keep the back and head on the bench at all times. One observer held his knees down on the bench, while another held his head lightly. Score was the number of times the barbell was returned to the start position in 20 seconds.

Data: Test-retest reliability of .90.

Measures: Factor loadings of: .38 on dynamic strength
.51 on Static strength
.44 on Weight Balance

II. A. Tests, Gross Body Movement dimensions

PUSH WEIGHTS, FEET - TIME LIMIT

Description: The subject was fitted with "iron boots" over his shoes. These "boots" allow the insertion of a single bar, through the two boots, with additional weights. The shoes each weighed five pounds and the added barbell weighed 17 lbs. The subject then lay on his back and raised the weights up until, with his legs fully extended, the weight was balanced over his head. This was the "start" position. He was given assistance in this balancing by a partner. To further assist this balancing and to emphasize the leg involvement a four inch mat was rolled 22 inches high to provide support under the small of his back. the subject practiced the sequences of a) lowering the weight as far as possible by bringing his knees down toward his chest, and then b) pushing the weight back up by straightening his legs. After a "ready", the "start" signal, the subject repeated this cycle as fast as possible. Score was the number of times the subject returned the barbell to the start position in 20 seconds.

Data: Test-retest reliability of .78.

Measures: Factor loadings of: .35 on Static strength
.43 on Weight balance

RAIL WALKING

Description: A hexagonal rail was constructed of 6 boards, 3/4 inch wide, $3\frac{1}{2}$ inches deep, and 24 inches long, fastened so that they formed a rigid equilateral hexagon. The subject walked backwards on the rail stepping on each segment in succession, touching only one segment at a time with each foot, (i.e., the foot was not allowed to overlap two segments). The long axis of the foot was kept parallel with the long axis of the segment. The subject's score was the number of segments traversed before he lost his balance and stepped off the rail or before he violated any of the above directions.

Measures: Factor loading of: .44 on Gross Body equilibrium

REVERSE SIT-UPS - TIME LIMIT

Description: The subject lay on the floor with hands behind his neck; his partner held his legs to the floor. He then raised the upper half of his body as high as possible. This height was noted,

and the subject returned to his original position. On the signal "go", the subject has to repeat as many of these "Reverse Sit-Ups" as possible in 20 seconds, raising his torso as far as possible (the first trial position) each time. The "one-two", sharp movement required was first demonstrated. Score was the number of times the subject raised himself in 20 seconds.

Data: Test-retest reliability of .76.

Measures: Factor loading of: .26 on Explosive strength.

ROPE CLIMB - TIME LIMIT

Description: The subject grasped a 20 foot high rope marked off in feet as high as he could in a standing position. This reaching height was recorded. On the signal "start", he pulled himself up the rope as fast and as high as possible. He was not allowed to jump up the rope, nor could he use his knees or legs to grasp the rope in climbing. The emphasis was on the arms. At the signal "stop" (after 6 seconds), his highest reach on the rope was recorded as his climbing height. Score was the subject's climbing height in six seconds minus his initial reaching height.

Data: Test-retest reliability of .80.

Measures: Factor loadings of: .67 on Dynamic strength
.41 on Explosive strength

600 YARD RUN-WALK

Description: Any track is appropriate that does not have sharp turns. The Ss are told that the object is to cover the distance in the shortest possible time. The running may be interspersed with walking, but they must finish as quickly as possible. Score is the time required, to the second.

Data: Test-retest reliability is .80

Measures: Stamina (Cardio-Vascular Endurance)

SHUTTLE RUN

Description: Two parallel lines 15 feet apart were made on the floor. The subject stood behind one line and on the signal "Go,"

ran to and across the other line, stopped, turned and ran back across the first line. Both feet had to cross the line each time. This completed one round trip. The subject's score was the length of time required to make five round trips.

Measures: Factor loading of: .63 on Explosive strength.

SHUTTLE RUN - TIMED

Description: Two parallel lines, 20 yards apart, were marked off on the macadam surface. The subject stood with one foot on the starting line, and at the command "go" ran the 20 yards to the second line, touched the ground on the this, until he had covered the 20 yards to the second line, touched the ground on the other side with either foot, and returned to the start line. He repeated this, until he had covered the 20 yards five times. On the last lap, upright standards and a finish tape were put up for the runner to break. Efficient turns between were encouraged. Score was the time for one complete run.

Data: Test-retest reliability of .85.

Measures: Factor loadings of: .39 on Dynamic strength
.77 on Explosive strength.

SIT-UPS - TIME LIMIT

Description: The subject was on his back, hands clasped behind neck, with a partner holding his legs down at the knees. Both shoulder blades were required to touch the deck before each sit-up and he was cautioned that his trunk was not to go further forward than a 90 degree angle with the floor. To emphasize the trunk, jerky movements were discouraged and the hands were kept behind the neck. The exercise was done rapidly and continuously, with two or three pre-test attempts to get the feel of it. Score was the number of times the vertical position was attained in 30 seconds.

Data: Test-retest reliability of .72.

Measures: Factor loadings of: .31 on Dynamic Strength
.33 on Explosive Strength

SOCCER DRIBBLE

Description: On the signal "Go," the subject dribbled the soccer ball with his feet around chairs in a prescribed path. Upon reach-

ing chair six he returned directly to the starting line. The subject's score was the length of time required to dribble around the chairs and return to the starting line.

Measures: Factor loading of .32 on Dynamic flexibility

SOFTBALL THROW

Description: The subject threw a 15" softball as far as possible without moving his feet. He was allowed to throw with either hand. Bricks with painted numbers marked off the field every five yards. Score was the best distance in three throws.

Data: Test-retest reliability of .93.

Measures: Factor loadings of: .32 on Static strength
.54 on Explosive strength

SQUAT THRUST - TIME LIMIT

Description: In a "push-up" position, arms outstretched, the subject placed his hands on the floor just forward of the shoulders. He supported the body, legs outstretched, in this way. At the signal "go", he was required to jump his legs up under his body to a position where his heels touched his buttocks; he then returned his legs to the fully extended position. He was required to repeat this cycle as many times as possible. Score was the number of times the subject returned to the starting position in 30 seconds.

Data: Test-retest reliability of .70.

Measures: Factor loadings of: .45 on Dynamic strength
.40 on Athletic experience - General

SQUAT, TWIST, and TOUCH

Description: A belt was placed around the subject's arms, and was tightened just enough to hold the subject's elbows at the sides of his chest, yet permit him to bring his palms together in front of his body. The subject stood between uprights which were so placed that the subject could just touch either of the top tap plates (which were adjusted to the level of the subject's elbows) by rotating his body to one side or the other. Two other tap plates were placed on the uprights 18" below the top tap plates. On the

signal "GO" the subject, standing upright, twisted to the right and touched the top tap plate with both hands, then squatted and touched the lower tap plate on his right with both hands. While in this squat position, the subject twisted to his left, touched the lower-left tap plate with both hands, and then rose and touched the top tap plate on his left with both hands. This completed one cycle. The subject's score was the number of cycles completed in 30 seconds.

Measures: Factor loading of: .53 on Dynamic strength

STANDING BROAD JUMP

Description: Subject put his toes up to a start line and then jumped as far forward as possible. The jump was performed on a mat marked off in two inch units. He was allowed to do anything with his arms. He was told that if he fell backwards the jump would not count. Score was the best jump out of three, as measured from the start line to the rear of the foot closest to the start line at impact.

Data: Test-retest reliability of .90.

Measures: Factor loadings of: .35 on Dynamic strength
.66 on Explosive strength

STICK BALANCE

Description: Keeping his feet stationary, the subject balanced a stick of wood, 3/4 inch x 3/4 inch x 12 inches, on the index finger of his nonpreferred hand. The subject determined his starting time by saying "GO", when he felt he had the stick balanced under control. His time ended when the stick touched any other part of his body, when the stick touched the floor, or when the subject moved either foot. The subject's score was the length of time he balanced the stick.

Measures: Factor loading of: .33 on Balance-Visual cues

TEN-YARD DASH - TIMED

Description: Subjects started with one knee on the ground and fingers on starting line. After specific instructions on starting procedures and how to run were given, the subjects ran and were timed individually in two separate runs. Score was the fastest time (to tenth of second) for the two sprints.

Data: Test-retest reliability of .62.

II. A. Tests, Gross Body Movement dimensions

Measures: Factor loadings of: .28 on Dynamic strength
.70 on Explosive strength

TOE TOUCHING

Description: The subject stood on a bench placing his toes even with the front edge. He bent over and reached down as far as possible with his hands while keeping his knees locked straight. A measuring scale was placed so that it extended 10 inches above and below the top of the bench. The subject's score was the distance on the scale he could touch and hold for two seconds. No bobbing was allowed.

Measures: Factor loadings of: .28 on Explosive strength
.39 on Extent Flexibility

TRUNK PULL - DYNAMOMETER

Description: Same assembly as was used in the Arm Pull-Dynamometer Test was adapted. A strap was fitted around the subject's chest, as high as possible. This strap was attached to one handle of the dynamometer while another strap was attached to the other handle to a pole. The subject sat straight up and on the signal "pull" he leaned forward as hard as he could. A partner sat on his knees to emphasize trunk involvement. Score was the best of three such pulls.

Data: Test-retest reliability of .67.

Measures: Factor loading of: .59 on Static strength

TWIST AND TOUCH (Also called Extent Flexibility)

Description: The subject stood with his nonpreferred side toward the wall, an arm's length away, with his feet together and his toes touching a line drawn perpendicular to the wall. A horizontal scale extended on either side of a line on the wall drawn perpendicular to the line on the floor, and was marked off from 0 inches to 30 inches. The subject kept his feet in place, twisted back around as far as possible and touched the wall with his preferred hand, keeping the hand at shoulder height with the palm facing the floor. The tester helped the subject keep his feet in place by placing his own foot against the subject's foot. The subject's score was the farthest point on the scale reached and held for at least two seconds.

II. A. Tests, Gross Body Movement dimensions

Data: Test-retest reliability of .90.

Measures: Factor loading of: .49 on Extent Flexibility

TWO FOOT CROSS BALANCE - EYES CLOSED

Description: Same as the Eyes Open version except that the eyes are closed.

Measures: Factor loading of .33 on Speed of limb movement

TWO FOOT CROSS BALANCE - EYES OPEN

Description: Same as the One Foot Cross Balance except that two feet were used on the rail and had to maintain contact with it throughout.

Measures: Factor loadings of: .26 on Balance-Visual
.31 on Speed of limb movement

TWO FOOT LENGTHWISE BALANCE - EYES OPEN

Description: Similar to One Foot Lengthwise Balance-Eyes Open except that two feet are used on a balance rail and these have to maintain contact with the rail throughout.

Measures: Factor loadings of: .53 on Gross Body Equilibrium
.32 on Balance-Visual

TWO FOOT TAPPING

Description: The subject stood facing a 12 inch square kick board attached to a wall 18 inches above the floor. On the signal "go," the subject lifted his right foot and tapped the kick board twice before returning it to the ground. He then did the same with his left foot. Two distinct taps were made with each foot each time and these four taps made one complete cycle. The score was the number of cycles completed in 15 seconds.

Measures: Factor loading of: .46 on Speed of limb movement

VERTICAL JUMP

Description: Subject jumped straight up as high as he could, next to a wall, without raising his arms. The observer stood to his side on an 18 inch stool and held a light 24" rubber tipped pointer

stick over the subject's head. The first gave the observer a general indication of the subject's jumping height. On subsequent jumps the observer placed the pointer against the scale mounted on the wall and watched to see if the subject knocked the stick up. After three or four jumps, the height of the best jump was recorded. Score was this height minus the subject's height.

Data: Test-retest reliability of .90.

Measures: Factor loadings of: .30 on Dynamic strength
.64 on Explosive strength

132. Fleishman, E. A., Thomas, P., and Munroe, P. The dimensions of physical fitness - a factor analysis of speed, flexibility, balance, and coordination tests. Office of Naval Research, Contract Nonr 609 (32), Tech. Report 3. Yale University, Dept. of Industrial Admin. and Psychology, New Haven, Conn., September 1961. (AD 265 367)

SPEED, FLEXIBILITY, BALANCE & COORDINATION TESTS

A technical report on one of the factor analytic studies presented in The Structure and Measurement of Physical Fitness by E. A. Fleishman, 1964.

133. Glassford, R. G., Baycroft, G. H. Y., Sedgwick, A. W., and MacNab, R. B. J. Comparison of maximal oxygen uptake values determined by predicted and actual methods. Journal of Applied Psychology, 1965, 20, 509-513.

MAXIMAL OXYGEN UPTAKE METHODS

Subjects: 24 males with the following average characteristics: age 23.4 years, height 179.3 cm., weight 75.3 kg., fitness index 70.1.

Method: the 24 subjects each completed a series of four Maximal Oxygen Uptake tests in a different order and took a prescribed fitness test. The interval between each of the four tests varied from 2 to 7 days. The four methods are given in detail but may be briefly described as follows:

II. A. Tests, Gross Body Movement dimensions

TAYLOR, BUSKIRK, AND HENSCHEL TEST: uses a treadmill, requires two or more days, and administration is based on the results of a previously given fitness test.

MITCHELL, SPROULE, AND CHAPMAN TEST: performance on a treadmill; testing is completed in one day.

ASTRAND TEST: performance is on a bicycle ergometer and apparently requires a little more than an hour.

ASTRAND-RHYMING INDIRECT TEST: a bicycle ergometer and a electrocardiograph are used. Administration time apparently requires 10-15 minutes. The maximal oxygen uptake is predicted by use of an Astrand-Rhyming nomogram, based on the steady state heart rate.

A means of collecting and measuring the expired air is needed for the first three tests above, i.e., they are direct tests.

Results: the comparative means and standard deviations for the above four tests were:

	Mean, liters/min	Standard Deviation
Taylor, Buskirk, and Henschel	3.758	.327
Mitchell, Sproule, and Chapman	3.752	.467
Astrand	3.485	.402
Astrand-Rhyming	3.714	.837

The intercorrelations for the direct tests ranged from .72 to .82. The correlations of the direct tests with the indirect test ranged from .65 to .78.

The authors indicate that the lower value derived from the direct Astrand test is the result of not loading a sufficiently large portion of the body for the long time period involved (bicycle pedaling as compared to treadmill running). They also suggest that the indirect method is a useful one, especially for a population unused to bicycling.

134. Graybiel, A. and Fregly, A. R. A new quantitative Ataxia Test Battery. Bureau of Medicine and Surgery Project MR005. 13-0061, Subtask 1, Report No. 107, NASA Order No. R-93. U.S. Naval Aviation Medical Center, Pensacola, Florida, March 1965. (AD 617 753)

II. A. Tests, Gross Body Movement dimensions

ATAXIA TEST BATTERY

Ages: 17 to 59 years
Cost: Construction of three rails required. Individual administration; 20-30 minutes.
Data: Data and descriptions are given for a long and a short test version. Since the short version was found to be more satisfactory, only information on the short version will be related here. Norms are given (828 normal males, 10 labyrintyine defectives, 32 male and female otoneurological patients, and 99 normal females).

Intra-test reliability: best three of five scores were recorded. Correlations of the trials ranged as follows: Walk H/T: .71 to .90, Stand E/O: .86, and Stand E/C: .91.

Test-retest reliability: performances of the first day correlated with the mean performances on nine successive days as follows: Walk H/T: .40, Stand E/O: .86, and Stand E/C: .91.

Intertest correlations: correlations between the three subtests ranged from .19 to .51.

Description: Battery consists of three subtests: Walk H/T Test, Stand E/O trials. WALK H/T TEST: the S must walk, using a heel-toe placement, on a 3/4" rail; the score is the number of steps successfully taken, up to five. STAND E/O TEST: the S must maintain his balance on a 3/4" rail while his eyes remain open, score is the number of seconds S remains on rail up to 60 seconds. STAND E/C TEST: the S must maintain his balance on a $2\frac{1}{4}$" rail, while his eyes are closed; score is the number of seconds S remains on the rail up to 60 seconds.

Measures: postural equilibrium, or vestibular ataxia.

Test Validity:
"In all instances, the performances of individuals with auricular involvement were significantly poorer than the performances of the normals." (p 7)
Canal Sickness susceptibility: "In a sample of twenty normal male subjects the test performances of the ten most susceptible to canal sickness on the Slow Rotation Room were compared with the test performances of the ten...least susceptible subjects....Generally, on all three tests the ten most susceptible subjects as a group attained higher performance scores than those attained by the least susceptible subjects." (p 9)

Effects of prolonged rotation: "Prerotation Test Battery performances were compared with post rotation performances in several groups of normal subjects who were rotated at a 10 RPM for 12 days in the SRR. Post-Testing occurred immediately upon cessation of rotation, and in all instances severe declines in test performances were evidenced." (p 9)

Test availability: full descriptions, scoring and administration procedures, and available data are reported in the appendix of this article on the following test: Ataxia Test Battery, Sharpened Romberg, Stand One Leg Eyes Closed, and Walk Line Eyes Closed.

135. Maritz, J. S., Morrison, J. F., Peter, J., Strydom, N. B., and Wyndham, C. H. A practical method of estimating an individual's maximal oxygen intake. Ergonomics, 1961, 4, 97-122.

MAXIMAL OXYGEN INTAKE ESTIMATION METHOD

Method: The subjects step on and off a foot stool, one foot high, at the rates of 6, 12 and 24 steps per minute. Some experimentation was done on 30 steps per minute but was not continued. For these subjects (African tribesmen mine laborers) the mean oxygen intake and heart rate was not significantly different between 24 and 30 steps per minute, indicating 30 steps/minute was too high a work rate to be maintained. The heart rate is measured at these rates of work and plotted on a graph with a 'standard' axis relating oxygen intake to rate to work. A straight line is fitted and extrapolated to the maximum heart rate value and the corresponding oxygen intake value is an estimate of the person's maximum oxygen intake.

Comments: The authors concluded from five months of study using both the step procedure and bicycle ergometer and taking ventilation measures that: "The random error in estimating oxygen intake from a 'standard' oxygen intake/work rate graph is therefore no greater than the variances in measured oxygen intake due to error and physiological variation. Measuring the ventilation volume during work does not improve the accuracy of the estimate of oxygen intake by more than a small percentage..." (p 117). The authors found the resting heart rates to be very variable and poor predictors of maximal oxygen intake, but found

no significant difference between the maximum heart rate of trained and untrained Bantu men. They found that, "The individual variability of maximum heart rate about the population mean is small." (p 117)

136. Meyers, C. R. & Blesh, T. E. Measurement In Physical Education. New York: The Ronald Press, 1962.

NEW YORK STATE PHYSICAL FITNESS TEST

Ages: grades 4-12
Cost: equipment incl. softball and posture chart; appears to be indiv.; probably 10-12 min. administration time.

Data: Norms for grades 4-12
No validity testing
Correlations between component and total scores is from .35 to 167
Correlations between components is -.02 to .49 with 36 of 42 correlations below .30.

Description: Posture: rated on 13 body segments compared to figure drawings. Accuracy: target throw used, 2 series of 10 throws. Dynamic Strength: Pull-Up Test with reverse grasp. Agility: a side step used with a 10 second time limit. Speed: 50 yd. dash. Balance: time feet are off the floor using squat stand. Endurance: treadmill for 1 min.

INDIANA MOTOR FITNESS TESTS

Age: college men
Cost:

Data: Norms available
Validity correlations with 12 item criterion with 2 measures each on strength, velocity, motor ability, and endurance were:
.86 on Index I: (chins & push-ups) x vertical jump ÷ 100
.82 on Index II: (chins & push-ups) x standing broad jump ÷ 100
.84 on Index III: (Straddle chins & push-ups) x vertical jump ÷ 100
.81 on Index IV: (Straddle chins & push-ups) x standing broad jump ÷ 100

II. A. Tests, Gross Body Movement dimensions

Description: (for above validities only 5 test items used) chins, straddle chins, push-ups, vertical jump, standing broad jump.

JCR TEST

Age: 18-45

Cost: 10 min. approximate administration time available shuttle course, construction of simple measuring board

Data: Validity Coefficients: .59 to .90
Reliability coefficients: .91 to .97

Description: 3 test items: vertical jump, chinning, 100 yd, shuttle run on 10 yd. course.

ARMY AIR FORCE (AAF) PHYSICAL FITNESS TEST

Data: Norms available
Test correlated with sum of 15 items selected as criterion at .86

Description: 3 test items: chinning, sit-ups in 2 min. 300 yd shuttle run.

II. B. Tests, Cognitive, Perceptual, Psychomotor, and Memory dimensions

137. Adams, Jack A. The prediction of advanced states of training on a complex psychomotor task. Hum Resources Res Cent, Res Bull 53-49, Lackland AFB, Texas. December 1953. (AD 22724)

PREDICTION OF COMPLEX COORDINATION TASK PERFORMANCE FROM A BATTERY OF TESTS DRAWN FROM THE PRINTED CLASSIFICATION TESTS AND APPARATUS TASKS

Subjects: 197 basic airmen

Results: Prediction of Complex Coordination Task performance, R values

Test scores	Initial performance	Final performance
Printed	.71	.56
Simple psychomotor	.55	.49
Initial complex psychomotor	.70	.61
Final complex psychomotor	.62	.71
Using best items only of total battery	--	.74

Data: reliabilities for complex psychomotor tests: initial trials: .87 to .98, final trials: .92 to .98

"The results generally fail to support the hypothesis that abilities required for performance on a complex psychomotor task become increasingly specific as training progresses with a consequent decreasing predictability of performance by classification tests." ...It appears from this data that consideration needs to be given to which practice level is more predictive. "...four classes of tests were found effective in predicting final Complex Coord: (a) printed and psychomotor speed tests, (b) some visualization and perceptual tests, (c) mechanical experience tests, and (d) measures from advanced stages of training on complex psychomotor tests."

138. Anderson, Gordon V, Fruchter, Benjamin, Manuel, Herschel T, and Worchel, Philip. Survey of research on spatial factors. San Antonio, Texas: AF Personnel & Training Research Center, Lackland AF Base, Research bulletin AFPTRC-TR-54-84. (AD 62 109.) No date given...past 1950.

SPATIAL ABILITIES TESTS

"Few studies of the validity of spatial tests have been done. Spatial tests have low validity for trade school courses... The tests have moderate validity

for engineering school grades... The highest correlations with grades in courses have been found with engineering drawing, mathematics, and science....In the Air Force studies...the second and third spatial factors have been shown to be valid for predicting success in training courses for aircrew positions and for a number of technical specialties involving mechanical and drafting activities and the operation of equipment." (p 43)

FLAGS - ORIGINAL VERSION

Odd-even reliability: .96

Summary of loadings from factor analytic studies: Spatial orientation and visualization: .64, .68, .73, .81. Spatial orientation: .73 and .44.

MacQUARRIE TEST FOR MECHANICAL ABILITY

Loading found in a factor analytic study:

Blocks score: Spatial orientation & visualization: .54

Copying score: Spatial orientation & visualization: .53

Spatial orientation: .36

MINNESOTA SPATIAL RELATIONS

Loadings of spatial factors found as a result of factor analysis:

Spatial orientation & visualization: .74

Spatial orientation: .58

139. Broadbent, D. E. Differences and interactions between stresses. Quarterly Journal of Experimental Psychology, 1963, 15, (3), 205-211.

SERIAL REACTION TEST-STRESS INTERACTIONS

The information presented below was taken from the author's Table 1. The reported effects of heat, noise, and sleep loss on Serial Reaction Test Performance are summarized.

	Speed	Errors	Place in workperiod where effect appears	Effect of Incentives	Interaction With Heat	Interaction With Noise
Heat	No effect	Increased	Throughout	(No Change in effect)	--	(None)
Noise	No effect	Increased	End	Increases effect	(None)	--
Loss of Sleep	Reduction	No effect	End	Decreases effect	None	Reduced effect

Results in brackets are not from the serial reaction test and are therefore not strictly comparable.

II. B. Tests, Cognitive, Perceptual, Psychomotor, and Memory dimensions

140. Brown, S. W., Guilford, J. P. and Hoepfner, R. A factor analysis of semantic memory abilities. Report no. 37, Psychological Lab., Univ. of Southern California, Los Angeles, Calif., July 1966. (AD 489 529 Limited)

MEANINGFUL MEMORY ABILITY TESTS

Factor analysis was performed on a battery of 59 measures on a population of 175 eleventh grade students to verify the existence of the factors predicted by the Structure-of-Intellect (SI) model. The tests with the highest loadings on Memory for Semantic Relations, MMR (later named Meaningful Memory Ability) are presented below. The means and standard deviations are available in the article.

REMEMBERED RELATIONS

Data: intratest reliability .63

Description: test consists of two parts, a study page with 15 items and a sentence completion (from a set of alternatives) page with 20 items. Time: 9 minutes.

Measures: factor loading of .50 on MMR

DESCRIPTIONS

Data: intratest reliability .68

Description: a two part test where the first part contains noun pairs (15 pairs) which are studied. The second part contains adjectives (30) which must be recognized if they describe any of the noun pairs. Time: 7 minutes.

Measures: factor loadings of .44 on MMR
.30 on Memory for semantic systems

MEMORY FOR WORD RELATIONS

Data: intratest reliability .72

Description: pairs (15) of words are studied in the first part. In the second part one member of each of the studied pairs is presented. A new pair must be chosen which best implies the same sense and direction.

II. B. Tests, Cognitive, Perceptual, Psychomotor, and Memory dimensions

Measures: Factor loadings of .42 on MMR
.34 on Memory for semantic classes

141. Brozek, and Taylor. Tests of motor functions in laboratory investigations on fitness. Project No. 21-32-004, Report No. 4, Contract No. AF 33 (038)-2194, USAF School of Aviation Medicine, Randolph Field, Texas. Lab. of Physiological Hygiene, University of Minnesota, Minneapolis, May 1954. (AD 54 726)

REACTION OF PSYCHOMOTOR AND PHYSICAL FITNESS FACTORS TO STRESSES

"A battery of tests of motor functions, applied in the context of comprehensive studies of "fitness and of changes in fitness under a variety of biological stresses, is described." The test battery included: Hand-Grip Dynamometer, Ball and Pipe Test, Two-Plate Tapping Test, Tapping Test (paper and pencil), Complex Reaction Time Test, and a track tracing test called Pattern Tracing. All of the tests are completely described.

The paper discusses the results of a series of studies concerned with two questions: what was the amount of practice needed on each test to establish a baseline performance and what would be the effect of the stresses of acute starvation, chronic semistarvation, heat, hard work, and lack of sleep (62 hour deprivation) on test performance as compared with plateau practice performance. With respect to the number of practice sessions required to reach a fairly stable practice level, the dynamometer tests required the least amount of time, the Tapping and Ball and Pipe tests required an intermediate time length, while the Reaction Time and Pattern Tracing Tests needed the most time.

In general, the stress effects were as follows: complex reaction time was affected by semistarvation; tapping tests (the mechanical test was more sensitive), ball and pipe and track tracing were affected most by acute starvation and hard work. (p 12) To assess the biological importance of the stresses, a displacement ratio (DR) was computed as follows: $DR = (M_C - M_E)/SD$, where M_C is the control mean, M_E is the experimental mean, and SD is the standard deviation.

Subjects: approximately 35 subjects participated in each of the practice studies. From these 32 subjects lived on a 1570 calories per day diet for 24 weeks for the semistarvation study. 12 subjects participated in the acute stress studies with the stresses separated by 6 to 8 weeks. The subjects were all young men taking part in studies as conscientious objectors.

II. B. Tests, Cognitive, Perceptual, Psychomotor, and Memory dimensions

BACK-PULL DYNAMOMETER TEST AND STRESSES

Apparatus: a horizontal handle bar attached by a chain to the spring scale mounted on a footboard. The chain was adjusted to individual height.

Data: One week test-retest reliabilities: initial practice: .864
at practice plateau: .925

Stress effects:

Stress	N, subjects	Mean Change, kg.	DR	F-test
Semistarvation	29	-49.7	-1.79	**
Acute starvation	12	- 7.2	- .26	
Hard work	9	-12.2	- .44	**
Heat	11	-15.3	- .55	**
Lack of sleep	10	- 7.1	- .26	*

** $p \leq .01$
* $p \leq .05$

BALL AND PIPE TEST AND STRESSES

Apparatus and method: A steel pipe, 30.5 cm long and 1.5 cm in diameter, was held by the subject vertically in front of himself with one hand. With the other hand he placed a steel ball bearing at the top of the pipe, let it drop through the pipe, and caught it at the bottom, repeating the performance as rapidly as possible for one minute. A safety net was suspended under the pipe to facilitate recovery of a dropped ball. A mechanical counter tabulated the number of drops, which was the score. The test was performed while the subject walked on a motor-driven treadmill, which increased the test difficulty and increased the coordination requirements.

Data: One week test-retest reliabilities: obtained from performance by the subjects when not on the treadmill and standing: initial practice: .758
at practice plateau: .849

Stress effects:

Stress	N, subjects	Mean Change, no.	DR	F-Test
Semistarvation@	32	- 3.3	- .61	**
Acute starvation	12	-10.3	-1.91	**
Hard work	10	- 1.7	- .31	*
Heat	11	- 1.7	- .31	
Lack of sleep	12	- 1.0	- .19	

@Performed standing, not on treadmill
** $p \leq .01$
* $p \leq .05$

II. B. Tests, Cognitive, Perceptual, Psychomotor, and Memory dimensions

COMPLEX REACTION TIME TEST AND STRESSES

Apparatus and method: The subject had to bend his knees and strike the appropriate key (green - left key; red - right key; white - both keys depressed simultaneously). The light stimuli were presented in random order and in an irregular time sequence. The score was the average time, in 1/100 second, of 25 reactions. The test was performed while walking on a treadmill. The response keys were large to eliminate the aiming factor.

Data: One week test-retest reliabilities: initial practice: .864
at practice plateau: .880

Stress effects:

Stress	N, subjects	Mean change, 1/100 secs.	DR	F-Test
Semistarvation	32	3.2	- .92	**
Acute starvation	12	9.0	-2.50	**
Hard work	10	2.1	- .58	**
Heat	11	3.1	- .86	*
Lack of sleep	12	1.4	- .39	*

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

HAND-GRIP DYNAMOMETER TEST AND STRESSES

Apparatus: a rectangular type of dynamometer was used.

Data: One week test-retest reliabilities: initial: .795
at practice plateau: .946

Stress effects:

Stress	N, subjects	Mean Change, kg.	DR	F-Test
Semistarvation	32	-16.4	-1.98	**
Acute starvation	12	.5	.06	
Hard work	10	- 2.8	- .34	**
Heat	12	- 2.7	- .33	**
Lack of sleep	12	.2	.02	

** $p < .01$

PATTERN TRACING TEST

Apparatus and method: The apparatus is very similar to the Track Tracing Test except that the pattern is more extensive. The grooved

pattern was traced by a stylus while walking on a treadmill. Both the number of the involuntary contacts between the stylus and the sides of the pattern, and the total duration of the contacts, recorded electrically, were used as performance scores.

Data: One week test-retest reliabilities: initial practice: .871 (duration)
.745 (number)
at practice plateau: .891 duration
.834 number

Stress effects:

Stress	N, Subjects	Mean Change, no. of contacts & duration in $\frac{1}{4}$ secs.		DR	F-Test	
Semistarvation	32	20.6@	6.1@	-1.55@- .81@	**@	**@
Acute starvation	12	9.8	8.5	- .73 -1.13	**	**
Hard work	10	7.6	3.7	- .57 - .49	*	
Heat	11	6.4	5.6	- .48 - .75		*
Lack of sleep	12	.1	4.0	0.00 - .53		**

@The first figure relates to number of errors; the second figure to duration of contact.
** $p<.01$
* $p<.05$

Note: the performance measures are differentially affected by the stresses.

TAPPING TEST, (PRINTED), AND STRESSES

Data: One week test-retest reliabilities: initial practice: .873
at practice plateau: .885

Stress effects:

Stress	N, Subjects	Mean Change, no. per 10 secs.	DR	F-Test
Semistarvation	32	- 3.3	- .61	**
Acute starvation	12 (?)	- .2		
Hard work	12 (?)	- .2		
Heat	12 (?)	- .5		
Lack of sleep	12 (?)	0.0		

** $p<.01$

TWO-PLATE TAPPING TEST AND STRESSES

Method: standard apparatus performed on a treadmill

Stress effects:

Stress	N, Subjects	Mean Change, no. per 10 secs.	DR	F-Test
Acute starvation	12	-10.3	-1.91	**
Hard work	10	- 1.7	- .31	*
Heat	11	- 1.7	- .31	
Lack of sleep	12	- 1.0	- .19	

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

Note: the mechanical tapping test is apparently far more sensitive to the acute starvation stress than is the printed tapping test.

142. Buros, Oscar Krisen, Editor. The Nineteen Forty Mental Measurements Yearbook. Highland Park, N. J.: Gryphon Press, 1941.

MINNESOTA RATE OF MANIPULATION TEST

Data: Adult norms are available but the norms of the 5-score test are inadequate. 2-score test: reviewer felt reliability and validity probably OK but was in doubt due to unclear presentation.

MINNESOTA SPATIAL RELATIONS TEST

Data: Norms are available
.80 reliability
.50 validity

Description: 4 boards with 58 differently shaped holes and matching forms each; increasing difficulty

O'CONNOR FINGER DEXTERITY TEST

Age: 14, and older

Data: no reliability or validity data given. Some independent research shows validity for watch factory, electrical & radio assemblers.

Measures: above research indicates rapid manipulation of small forms.

II. B. Tests, Cognitive, Perceptual, Psychomotor, and Memory dimensions

O'CONNOR TWEEZER DEXTERITY TEST

Age: 14, and older

Data: no reliability given. Independent research indicates predictive validity for watch makers but not dentists (1940ed)

Measures: rapid manipulation of small objects and fine control precision.

143. Buros, Oscar Krisen, Editor. The Third Mental Measurements Yearbook. Highland Park, N. Y.: Gryphon Press, 1949.

BENGE HAN-DEXTERITY TEST

Age: adults

Cost: indiv., 10-20 min., $5/test outfit

Data: No reliability data
Validity is limited and not revised

Description: Board with 10 pegs. 4 trials: right, left, both, alternate.

Measures: Rough measure of hand, eye and arm movements.

MACQUARRIES TEST FOR MECHANICAL ABILITY

Age: 16, and older

Cost: group admin, 25 minutes, 1 form, $1.75/25 forms, 25¢ for specimen set (Calif Test Bureau)

Data: Norms available
Reliabilities: .72 - .86 on parts, .90 on whole
Validity correlations: .42 on one, "OK" on others

Description: Items: tracing, tapping, dotting, aiming with speed; (manual dexterity tests); copying, location, blocks & pursuit (IQ tests).

Measures: Finger & hand dexterity, visual acuity & muscular control, spatial relations (the highest correlations with Minn Test was .24 so considered to measure different manipulative abilities).

II. B. Tests, Cognitive, Perceptual, Psychomotor, and Memory dimensions

MINNESOTA RATE OF MANIPULATION TEST(Rev. of Minnesota Manual Dexterity Test)

Data: 5-score test: reviewer felt 3 new tests added little (intercorrelations of .50), validation was poor, reliability of .90, but data inadequate.

Description: 5 scores: placing, turning, displacing, 1-and 2-hand turning & placing. Turning: peg taken out and turned with one hand then replaced by other hand. Placing: peg placed into hole.

Measures: rapidity of movement in working hands and fingers. If job requires attention to many and changing details, reaction to observed details, then use of Minn Spatial Relat Test also recommended. Placing test: not dependent on coordination of 2 hands nor delicate control. Turning test: rapidity & dexterity in manipulations, requiring 2-hand coordination.

MINNESOTA SPATIAL RELATIONS TEST

Age: 11, and older

Cost: individual, 1 form, 15-45 minutes, $48 per set. A short form is available.

Measures: speed and accuracy in reacting to variety of details of spatial relations. Measures 2-dimensional spatial relations. Compared to Kent-Shakow Test, it is easier, speed is more important, and it does NOT have the the combining and integrating elements.

PENNSYLVANIA BI-MANUAL WORK SAMPLE

Age: 17, and older

Cost: indiv., 10-20 minutes, 1 form, $15 per test outfit.

Data: No validity data
Norms available
Reliability: .95 for split half, implies .80-.85 for test-retest
Validity: correlations with other dexterity tests is .40.
correlations of parts 1 & 2 is .55

Description: 2 tasks. Task 1: select bolt with one hand, nut with the other, assemble and place in hole (100 times). Task 2: Take it all apart again (main contribution of task 2 - saves work for the tester!)

II. B. Tests, Cognitive, Perceptual, Psychomotor, and Memory dimensions

Measures: Finger dexterity of both hands, gross movements of both arms, eye-handcoordination, bimanual coordination, and ability to use both hands in cooperation.

144. Buros, Oscar Krisen, Editor. The Fourth Mental Measurements Yearbook. Highland Park, N. J.: Gryphon Press, 1953.

CALIFORNIA TEST OF MENTAL MATURITY

Data: Total score reliabilities range from .92 to .95.
Part score reliabilities range from .81 to .95.
Validity of component scores: subtest intercorrelations range mainly from .20 to .40.
Norms are available.

THE GUILFORD-ZIMMERMAN APTITUDE SURVEY

These are factorially designed tests with the loadings ranging from .52 to .89.

The spatial tests correlate highly with each other. The general reasoning test has high verbal loadings in some groups.

Description:

Verbal comprehension:	a vocabulary test
General Reasoning:	quantitative reasoning test; problems stated in verbal terms. Items which correlated highly with Numerical Operations were eliminated.
Numerical Operations:	addition, subtraction and multiplication problems.
Perceptual Speed:	pictures must be matched by comparing fine details.
*Spatial Orientation:	examinee must indicate changes in the position of the prow of a motorboat with reference to a landscape in the background.
Spatial Visualization:	requires visualization of the rotations of an object on its 3 axes.
Mechanical Knowledge:	requires knowledge about plumbing, auto repair, etc.

*See Spatial orientation test references for more information.

II. B. Tests, Cognitive, Perceptual, Psychomotor, and Memory dimensions

SRA PRIMARY MENTAL ABILITIES

Several reviews of this test appear in Buros' 4th edition. The concensus of opinion seems to be that, although this is a well constructed test, it is not closely related to the Tests of Primary Mental Abilities which were used in Thurstone's early factor analytic work. Further, the reliability and validity data were questioned by the reviewers.

STROMBERG DEXTERITY TEST

Adults

Cost: indiv., 8-15 min., 1 form, $30/set, 35¢/manual

Data: Norms not complete.
Validity data poor.
Split half reliability is .84-.87

Description: two formboards. Must transfer colored disks from one board to the other in certain order and then back in a different order.

Measures: Visual discrimination, manual dexterity, nonverbal IQ, and maybe a spatial visualization component.

145. Buros, Oscar Krisen, Editor. The Fifth Mental Measurements Yearbook. Highland Park, N.J.: Gryphon Press, 1959.

CRAWFORD SMALL PARTS DEXTERITY TEST

Age: high school & adults

Cost: indiv., 1 form, 10-25 minutes, $27.50 per set.

Data: Norms available
Scanty validity
Reliability: split half, .8-.94 on part 1, .9-.98 on part 2
Part 1 correlates with part 2 at .35 - .50

Description: 2 scores: 1) pins & collars, 2) screws. Consists of a metal plate with 2 sets (threaded & smooth) of holes, 6x6 = 36 holes. Part 1, using smooth set: place pin in hole with forceps, then collar over. Part 2, using threaded set: start screw manually, then screw in with screwdriver.

Measures: "Complex of perception-dexterity coordinations", "composite measure of a complex motor pattern.

146. Buros, Oscar Krisen, Editor. The Sixth Mental Measurements Yearbook. Highland Park, N. J.: Gryphon Press, 1965.

ARMY GENERAL CLASSIFICATION TEST, FIRST CIVILIAN EDITION (AGCT)

Cost: $10.80 per 20 tests, 60¢ per technical report, 75¢ per specimen set of either edition. Hand scoring edition: 19 pgs per pad; $2.40 per 20 answer pads. IBM Machine scoring edition; $5 per 100 IBM answer sheets, $1 per set of scoring pencils. Group administration, 50 minutes.

Data: Reliabilities-majority fall in the .90's and are based on studies of military personnel. Norms are available but some are based on scores from other sources rather than on the AGCT. Validity data is given but the Buro's reviewers expressed doubts regarding the relationship between the data and the stated uses of the test.

Description: Used for grades 9-16 and for adults. One form ('47, identical with the 1940 Form Ia of the Army edition); two editions; revised manual; technical report; (Note: forms Ic & Id were used all during the 2nd World War; Ia was considered to be inadequate by the Army ex: Buros, 4th ed). The test consist of three types of problems; vocabulary, arithmetic word problems, and block counting.

Measures: vocabulary problems measure a verbal factor; arithmetic word problems measure number and reasoning factors and block counting measures a space factor. (Buro's reviewer states that included two part score intercorrelation studies indicate that the 3 types of items are not factor specific.

Comments: Reviewers indicate that there exists a large varience between AGCT mean scores for different groups and that the technical data is not adequate.

CALIFORNIA TEST OF MENTAL MATURITY, 1963 Revision

Ages: tests available for four levels, including from Grade 4 to adults.

Cost: $7 per 35 tests; 10¢ per set of IBM answer sheet-profiles; machine (80¢) or hand (40¢) scoring stencils; 50¢ per guide to interpretation; $1 per specimen set on any one level. Group administration; 91 minutes for adult level.

Data: no data on reliability and validity of the revised long form.

Description: 8 scores: logical reasoning, spatial relationships, numerical reasoning, verbal concepts, memory, language total, non-language total, total.

FLAGS: A TEST OF SPACE THINKING

Cost: $4 per 20 tests; $1 per specimen set. 10 minutes, group administration.

Data: Norms available on males only.
No data given on reliability or validity.

Description: Consists of 21 items each requiring six responses. Reliability and validity data are not reported because although these test items are of the same type as the earlier version of the test, a different flag design is used for each item.

Measures: space factors.

THE GUILFORD-ZIMMERMAN APTITUDE SURVEY

Ages: Grades 9-16 and adults

Cost: IBM except for parts 3 and 4; 7 parts; 4¢ per IBM answer sheet for any one part; 75¢ per scoring stencil for any one part except parts 3 and 4 ($1); 40¢ per manual; $2.35 per complete specimen set. Group administration.

Part 1, Verbal Comprehension: $2.50 per 25 tests; 75¢ per specimen set; 30 minutes
Part 2, General Reasoning: $2.50 per 25 tests; 65¢ per specimen set; 13 minutes
Part 3, Numerical Operations: $2.50 per 25 tests; 60¢ per specimen set; 10 minutes
Part 4, Perceptual Speed: $2.50 per 25 tests; 60 ¢ per specimen set; 10 minutes
Part 5, Spatial Orientation: $4 per 25 tests; 75¢ per specimen set; 20 minutes
Part 6, Spatial Visualization: $4 per 25 tests; 75¢ per specimen set; 15 minutes
Part 7, Mechanical Knowledge: $4 per 25 tests; 75¢ per specimen set; 35 minutes

KIT OF REFERENCE TESTS FOR COGNITIVE FACTORS

Cost and sources for this battery listed under item No. 551.

II. B. Tests, Cognitive, Perceptual, Psychomotor, and Memory dimensions

THE HENMON-NELSON TESTS OF MENTAL ABILITY, REVISED ED.

Cost: $2.55/100 MRC answer cards. Cost for tests applicable to Grades 3-6, 6-9, and 9-12: $3.60/35 tests, $1.38/35 IBM answer sheets, 21¢ per pencil, $2.25/specimen set; 35 minute group administration. Cost for test applicable to Grades 13-17: $3.60/35 tests, $2.52/35 self-marking answer sheets, $2.91/100 IBM answer sheets, 64¢/set of pencils, $1/specimen set; 45 minute group administration.

Data: percentile norms available thru college freshmen. Odd-even reliabilities (N = 100) range from .89 to .95 across 3 scores, forms A & B. 35 day test-retest reliabilities, using alternate forms, range from .84 to .89 across 3 scores.
Validities: Correlation with freshmen grades (N = 95) range from .46 to .54 across 3 scores
Correlation with ACE scores: .55 with quantitative & total scores
.75 with verbal score

Description(grades 13-17): 100 items classified as follows: 47 vocabulary definition, 22 number series, 17 arithmetic reasoning, 12 verbal analogies, 1 sentence arrangement, & 1 verbal-math reasoning. Three scores: total, verbal, and quantitative. Buros reviewer comments that test is difficult for even the brightest college freshmen.

Measures: Buros' reviewer comments that SCAT, CQT, & OSUPE are more dependent on prior school learning whereas this test provides an index of intellectual skills which are less a function of schooling.

MATCH PROBLEMS II

Publication source and costs listed under item no. 554.

MINNESOTA RATE OF MANIPULATION TEST

Age: adult

Cost: individual administration, 10-15 minutes, 1 form, $34 per set, 75¢ per additional manual.

O'CONNOR FINGER DEXTERITY TEST

Cost: individual administration, 8-16 minutes, 1 form, $20 per set.

O'CONNOR TWEEZER DEXTERITY TEST

Cost: individual administration, 8-10 minutes, 1 form, $21 per set.

II. B. Tests, Cognitive, Perceptual, Psychomotor, and Memory dimensions

PROGRESSIVE MATRICES

Measures: attempt to measure 'g' via various forms of perceptual reasoning.

PURDUE PEGBOARD

Age: adults

Cost: 10-20 min, form & profile, apparatus (poorly constructed), $18.95/ apparatus and manual, 95¢/20 profiles. Group administration, time limit test

Data: Norms given but no group breakdown.
Validity not given (supposed to be related to motor coordination)
.85 reliability (only if peg insertion parts given 3 times and assembly part given 2 times)

Description: 5 scores; insert pegs with/right hand, left hand, both hands, rt&lf&both hands, assembly of washer & collar over peg.

Measures: Motor coordination

SRA PRIMARY MENTAL ABILITIES, REVISED

Note: earlier eds called Tests for Primary Mental Abilities & Chicago Tests of Primary Mental Abilities.

Ages: 5 editions available covering grades kindergarten thru 12.

Cost: (grades 9-12) $11 per 20 tests; $5 per 100 IBM scorable answer sheets; $1 per set of scoring stencils; 70¢ per 20 profiles; $1 per specimen set. Group administration: 74 min.

Data: no data on reliability and validity of present edition. Previous edition still available.

Description: 5 scores: verbal meaning, number facility, reasoning, spatial relations, total.

TESTS OF MECHANICAL COMPREHENSION

Ages: four editions are available to test different groups of individuals. Grades 9 and over are covered.

Cost: $4.75 per 25 tests; $2 per 50 IBM answer sheets; 40¢ per manual and scoring stencils; 50¢ per specimen set. Group administration: 25 to 45 minutes.

No data given.

II. B. Tests, Cognitive, Perceptual, Psychomotor, and Memory dimensions

WECHSLER ADULT INTELLIGENCE SCALE (WAIS), Revised Form 1 of the Wechsler-Bellevue Intelligence Scale

Ages: 16 and over

Cost: $24 per set of testing materials, 25 record booklets, and manual; $2.10 per 25 record booklets; 90¢ per 25 supplementary record sheets; $3 per manual. Individual administration: 40 to 60 min.

Description: 14 scores: verbal (information, comprehension, arithmetic, similarities, digit span, vocabulary, total,), performance (digit symbol, picture completion, block design, picture arrangement, object assembly, total), total.

WECHSLER-BELLEVUE INTELLIGENCE SCALE, Form 2 of the WAIS

Age: 10 years and over

Cost: $21 per set of testing materials, 25 record forms and manual; $2.25 per manual.

See Wechsler Adult Intelligence Scale for further information.

WONDERLIC PERSONNEL TEST

Age: Adults

Cost: $8 per 100 tests and manual; 50¢ per manual; $4 per introductory package of manual, norms supplement, 3 other reports, and 20 copies each of Forms A and B or 1 and 2. Group administration: 12 minutes. Forms D and F are industrial adaptations.

Data: test-retest, 12 minutes, using alternate forms, is .82 to .94. Odd-even internal consistency ranges from .88 to .94
Validity: differentiates between good and poor groups of employees. Norms are available.

Description: spiral-omnibus type of intelligence test of 50 items of an academic nature. Items are arranged in the order of easy to difficult.

147. Clark, B. and Graybiel, A. Human performance during adaptation to stress in the Pensacola Slow Rotation Room. Report No. 52, Bureau of Medicine and Surgery Research Proj. MR005.13-6001 Subtask 1, U.S. Naval School of Aviation Medicine, U.S. Naval Aviation Medical Center, Pensacola, Fla, May 18, 1960. (AD 244 935)

II. B. Tests, Cognitive, Perceptual, Psychomotor, and Memory dimensions

PERFORMANCE DURING ROTATION

Subjects: 5 normal males and 1 male with no vestibular function

Method: the subjects were exposed to periods of constant rotation in the Pensacola Slow Rotation Room which varied from 1.71 to 10.00 rpm for periods of two days each. The tests included: arithmetic, walking, body sway, strength of grip, ball throwing, dart tossing, opening locks, hand steadiness, card sorting and dial setting. Performance was practiced prior to the trials, and then tested both during rotation and immediately following rotation.

Results: The normal subjects were stressed due to the random stimulation of the semicircular canals during head movements. The amount of stress varied from subject to subject, within each run, and increased as the angular velocity of the room increased. Performance decrements occurred uniformly in the walking and body sway tests during both the rotation and post-rotation trial periods as a function of velocity. Performances on the other tests, however, were determined not only by the amount of sickness felt by the subject, but also, apparently, by the determination on the part of the subject to succeed. In other words, some of the subjects, even though very sick, performed very well on the tests.

148. Cope, F. W., & Jensen, R. Preliminary report on an Automated System for the Study of mental function in the human subjected to acceleration stress. Report NADC-MA-6113, BuWeps. Wep. Task Nos. R360 FR102/2021/R01 101001 (5915M), and RAE 20J 031/2021/R005 Q1 003, Aviation Med. Acceleration Lab., U.S. Naval Air Development Center, Johnsville, Pa. (AD 263 609)

AUTOMATED NUMERICAL FUNCTION TEST FOR STUDY OF ACCELERATION STRESS

Cost: Building of automated system requires: tape recorder, loudspeaker, earphones, switches & wiring, and a computer with/logic circuit, timing ability, and integrator output recorded on a strip chart. (small combination digital-analog system)

Data: 3 male experienced acceleration subjects were run. The test performance did show a decrement for the three subjects when under a 4.6 G force. Subjects were able to continue performance during greyout.

Description: Two random numbers were read to the subject every 3 seconds via earphones. The subject had to decide whether the total was odd or even and close a right hand trigger switch if the answer was even and a left handswitch if odd. The slope of a continuous integrated readout line indicated the degree to which the subject was either 1) thinking quickly and/or making few mistakes, or 2) thinking slowly and/or making frequent mistakes. Subjects have 10 minutes practice then a $4\frac{1}{2}$ minute trial, 3 minutes of which were under 4.6 G.

Measures: "Mental functioning" decrement under stress

Note: Article gives details for construction of apparatus and test administration.

149. Cronbach, L. J. Essentials of psychological testing. (2nd ed.) New York: Harper & Row, 1960.

COMMENTS RE: FACTOR ANALYSIS & ABILITIES

"One gets out of a factor analysis only what he puts in. This remark has become trite, but it is of basic importance. Factor analysis sorts the abilities present in the test battery; it does not unearth new ones." (p 261)

"It is equally possible to argue that correlations between abilities are produced by experience...On the other hand, we may yet find intellectual patterns of undeniable hereditary origin." (p 262)

"Probably the correct position to take is that factor studies clarify what present tests measure." (p 262)

BLOCK DESIGN TEST, A SUBTEST OF THE WAIS

Measures: nonverbal measure of analytic and synthetic reasoning with a wide range of difficulty.

Description: one-inch cubes are used with two red sides, two white sides and two red and white sides. The examinee must duplicate each of 10 designs made by the examiner within a time limit. Examinee is scored on time taken, errors, reactions to and methods of dealing with the task. Actual test time is 14 minutes.

II. B. Tests, Cognitive, Perceptual, Psychomotor, and Memory dimensions

	Verbal Comprehension	Verbal Problem Solving	Nonverbal Reasoning	Numerical Speed	Information	Perceptual Speed	Visualization	Similarities	Fluency (?)	Unidentified	Unique and error
1. Age				.32						.40	
2. Otis Beta	.54			.30						.47	
3. Perceptual Speed				.30		.52					
4. Numerical Operations				.74		.31					
5. Arithmetic Reasoning		.44	.32								
6. Mechanical Principles			.39				.64				
7. Mechanical Information			.44								
8. Science Information	.57		.32								
9. Synonyms	.75					.31					
10. Word Definition	.80									.37	
11. Information--group	.61				.44						
12. Comprehension--group	.38								.62		
13. Similarities--group		.32			.44	.38		.65			
Wechsler subtests:											
14. W Information	.42				.56						.46
15. W Comprehension		.33									.62
16. W Digit Span			.34						.37		.52
17. W Arithmetic		.57	.34	.36	.32						
18. W Similarities	.31							.65			.54
19. W Vocabulary	.60										.45
20. W Picture Arrangement										.49	.47
21. W Picture Completion							.38				.58
22. W Block Design			.41		.30	.38	.44				.40
23. W Object Assembly						.42	.34				.56
24. W Digit Symbol				.52		.37			.30		.61

II. B. Tests, Cognitive, Perceptual, Psychomotor, and Memory dimensions

CALIFORNIA TEST OF MENTAL MATURITY

Referring to the usefulness of the subscores of this test, the author comments, "...these subscores have dubious validity and should be given little attention." (p 229)

DIGIT SPAN, A SUBTEST OF THE WAIS

Description: The subject is asked to repeat digits forward and backward.

DIGIT SYMBOL TEST, A SUBTEST OF THE WAIS

Description: ten numbers are listed, each with a different symbol. A series of numbers are given for which the examinee must write the appropriate symbol. Score is the number within the time limit.

Measures: "Learning the code is easy enough that for above-average adults the score becomes a measure of writing speed rather than mental ability." (p 194)

TESTS OF MECHANICAL COMPREHENSION

Measures: the ability to perceive and to understand the relationship of physical forces and mechanical elements in practical situations. A high score on this test implies the person would probably tend to learn readily the principles of operation and repair of complex devices.

Comments: "...one of the most widely used tests..." (p 39).

WECHSLER ADULT INTELLIGENCE SCALE, OR WAIS

Data: split-half reliability is .97. Difference between verbal and performance scores reliable at .74. Correlation with achievement tests reported as .84.

WECHSLER-BELLEVUE, FORM 1

The results of an unpublished factor analytic study of the Wechsler-Bellevue are presented. The Otis Beta was included in the set of reference tests. The entire battery was administered to 202 eighth grade pupils. The factor loadings below are taken from the author's Table 33 (p 266).

150. Denison, D. M. & Ledwith, F. Complex reaction times at a simulated cabin altitude of 8000 feet. RAF Inst. of Aviation Medicine, Farnborough, England, April 1965. (AD 806 972)

VISUAL TASK AND HYPOXIC STRESS: SPATIAL TRANSFORMATION OF INFORMATION

Cost: equipment required includes picture screen, 2 projectors with automatic slide change, shutters with timing mechanism, 2 response buttons, manual reset button, and make up of slides-33 originals, 145 total.

Data: 8 subjects were tested with performance under conditions equivalent to air at ground level (4 subjects) being compared with performance at 8000 ft. (4 subjects), the difference was significant at $p < .05$. Because of other research completed, authors felt this was due to altitude rather than subject difference. More difficult items were more sensitive. (Authors state that changes in mean performance are the least sensitive impairment indicators). Performance was significantly affected only during the first session with impairment being steadily reduced with practice (implications re: novel situations).

Description: This article contains test content, administration, and construction details. Consisted of a orange or blue warning signal followed by a slide projection of a man in one of 4 positions with orange disc in one hand and blue in the other. Subject has to decide if hand holding warning signal colored disc is the right or left hand and respond with his own appropriate hand. Concurrent with test performance, subjects exercised on a bicycle ergometer at a self-maintained work load of 27 watts. Score consisted of reaction times.

Measures: ability to assimilate visually presented information on orientation with respect to some external reference & use it in relation to their 'own body' frame of reference. Thought to measure ability of pilots to maintain orientation while flying by instruments alone.

151. Fleishman, E. A. Dimensional analysis of psychomotor abilities. Journal of Experimental Psychology, 1954, 48, 437-454.

II. B. Tests, Cognitive, Perceptual, Psychomotor, and Memory dimensions

HAND PRECISION AIMING - CORRECTS
Measures: Speed of arm movement: .14

HAND PRECISION AIMING - ERRORS
Measures: factor loading on Speed of arm movement: .01

LARGE TAPPING TEST
Measures: factor loadings on Wrist and finger speed: .74
Speed of arm movement: .21

MEDIUM TAPPING TEST
Measures: factor loading on Wrist and finger speed: .74

PIN STICK TEST
Measures: factor loading on Finger Dexterity: .19

PURSUIT AIMING I TEST
Measures: factor loadings on Wrist and finger speed: .52
Aiming: .68

PURSUIT AIMING II TEST
Measures: factor loadings on Wrist and finger speed: .48
Aiming: .63

STEADINESS TEST
Measures: factor loading on Arm-hand steadiness: .31

II. B. Tests, Cognitive, Perceptual, Psychomotor, and Memory dimensions

STEADINESS AIMING

Measures: factor loading of .60 on Arm-Hand Steadiness

TWO-PLATE TAPPING

Measures: factor loadings of: .24 on Manual Dexterity
.54 on Speed of Arm Movement
.36 on Wrist-Finger Speed

152. Fleishman, E. A. Evaluations of psychomotor tests for pilot selection: the Direction Control and Compensatory Balance Tests. Project no. 7701, Air Force Personnel and Training Research Center, Air Research and Development Command, Lackland AFB, Texas, December 1954 (AD 64760)

DIRECTION CONTROL

This article contains complete administration protocols, wiring diagrams and descriptions, and stanine conversion tables for the Direction Control test and a Compensatory Balance test.

153. Fleishman, E. A. A note on the Minnesota Rate of Manipulation Test as a time limit test. Educational and Psychological Measurement, 1954, 14, 156-160.

MINNESOTA RATE OF MANIPULATION TEST

Supports the administration of this test as a time limit test.

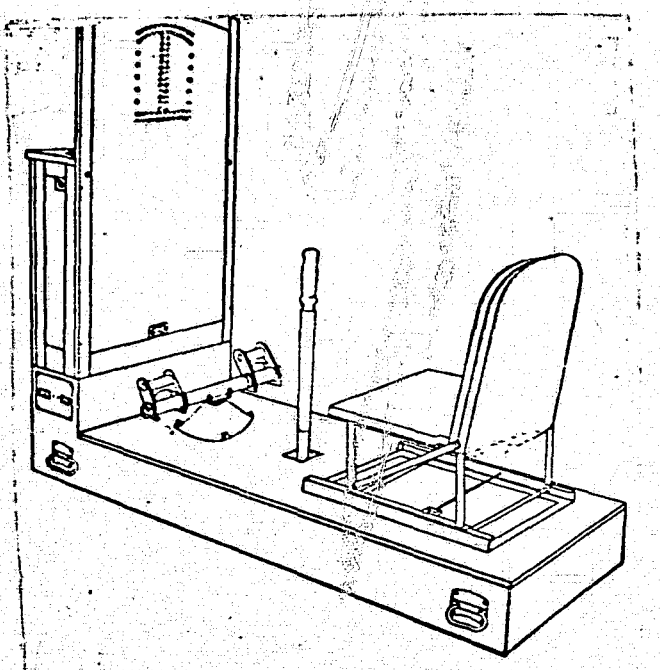
154. Fleishman, Edwin A. A comparative study of aptitude patterns in unskilled and skilled psychomotor performances. Journal of Applied Psychology, 1957, 41, 263-272.

The results of this factor analytic study "...indicate that there was no over-all decrease in predictability of performance from independent measures as practice continues. It is merely the particular combination of common factors that changes." The data was factor analyzed first with respect to the early trials and then again with respect to the late trials on the more complex psychomotor tasks.

COMPLEX COORDINATION TASK

Cost: 2½ hours administration time spread over 2 days and the instrument cost

Description: The subject is required to make complex motor adjustments of stick and pedal controls in response to successively presented patterns of visual cues. Stimulus and response lights in three dimensions must all be aligned properly before a new setting is present. Subjects received 64 two minute trials distributed over two days with a morning and afternoon session each day. Scores recorded were the numner of completed settings during each trial.



Measures: factor loadings:

Variable	Factors** I	II	III	IV	V	VI	VII	VIII
Results of Analysis using early trials:								
Complex Coord. Trials 1-5	05	35	21	26	35	38	42	22
Complex Coord. Trials 12-16	23	16	23	21	19	47	46	41
Complex Coord. Trials 49-53	42	13	-03	22	19	38	47	52
Complex Coord. Trials 60-64	43	12	01	20	19	34	40	58

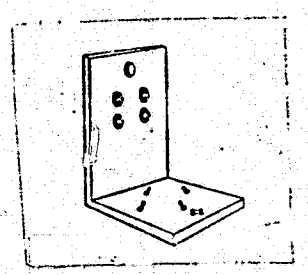
II. B. Tests, Cognitive, Perceptual, Psychomotor, and Memory dimensions

Variable	Factors** I	II	III	IV	V	VI	VII	VIII
Results of analysis using late trials:								
Complex Coord. Trials 1-5	03	41	21	29	36	32	40	24
Complex Coord. Trials 12-16	19	27	18	16	32	44	44	39
Complex Coord. Trials 49-53	38	11	18	20	06	48	45	47
Complex Coord. Trials 60-64	37	05	21	17	13	44	45	54

**Factor identification: I-Speed of Arm Movement; II-Visualization; III-Perceptual Speed; IV-Mechanical Experience; V-Spatial Orientation; VI-Response Orientation; VII-Fine Control Sensitivity; VIII-Complex Coordination Within-Task factor.

DISCRIMINATION REACTION TIME

Cost: 20-25 minutes and the instrument cost.



Description: The subject manipulates one of four toggle switches as quickly as possible in response to a series of visual stimulus patterns differing from one another with respect to the spatial arrangement of their component parts (e.g., position of a lighted red lamp relative to a lighted green lamp.) Score is the cumulated reaction time for each of a series of reaction trials, where a trial is ten successive reactions. Two minutes rest was given after every 80 reactions. 24 trials.

Measures: factor loadings:

Trials 1-5		Trials 20-24	
Speed of arm movement	.28	Speed of arm movement	.46
Spatial orientation	.46	Spatial orientation	.38
Response orientation	.40	Response orientation	.28

GENERAL MECHANICS TEST

Description: Printed items which require knowledge of practical mechanical information dealing with the use or operation of familiar mechanical methods and devices.

Measures: factor loadings:

	Early Loading	Late Loading
Mechanical experience	.65	.64

II. B. Tests, Cognitive, Perceptual, Psychomotor, and Memory dimensions

INSTRUMENT COMPREHENSION

Description: For each item, which presents views of cockpit instruments, the examinee must determine the proper position and orientation of an airplane.

Measures: Factor loadings: (factor analysis done once using early training performance, again using late training performance):

Factors	Early Loadings	Late Loadings
Perceptual speed	.18	.29
Spatial orientation	.54	.49

JUMP VISUAL REACTION TIME TEST

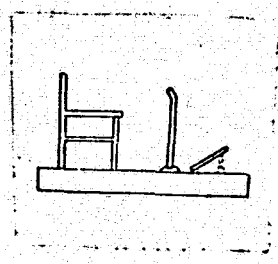
Description: Strike a button as quickly as possible by an arm-hand movement, in response to a light when it appears. Score is cumulated reaction time for a series of 10 reactions.

Measures: factor loadings:

Factors	Early Loadings	Late Loadings
Speed of arm movement	.60	.65

KINESTHETIC COORDINATION

Cost: 25 minutes individual administration, and instrument cost



Description: The subject attempts to coordinate his pressure against a stick and medal control simultaneously in order to match the considerable tension exerted against these controls through a hydraulic system. When he succeeds in countermatching the control forces, a new setting of control tensions must then be countermatched. Score was the number of settings matched in each of ten 1-minute trials separated by 1-minute rests.

Measures: factor loadings:

Trials 1-5		Trials 6-10	
Mechanical experience	.28	Response orientation	.40
Response orientation	.35		

II. B. Tests, Cognitive, Perceptual, Psychomotor, and Memory dimensions

MECHANICAL PRINCIPLES TEST

Description: Pictorial items require the comprehension of principles and mechanisms, such as leverage or rotation and transformation of motion, involved in the action and uses of various mechanical devices.

Measures: factor loadings:

Factors	Early Loadings	Late Loadings
Visualization	.53	.40
Mechanical experience	.52	.61

PATTERN COMPREHENSION TEST

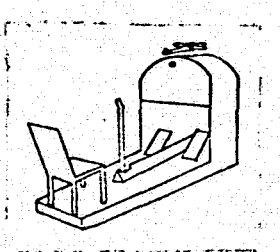
Description: A series of drawings is presented which require visualization of relationships between components of solids and their folded flat projections.

Measures: (factor analysis using early and late performances)

Factors	Early loading	Late loading
Visualization	.66	.60
Perceptual speed	.18	.36
Spatial orientation	.34	.31

PLANE CONTROL

Cost: individual administration, 50 minutes, and instrument cost.



Description: The attitude of a model airplane (mounted in front of the subject) is varied irregularly in its roll, pitch, and yaw axes by a motor driven cam system. The subject attempts to keep the airplace in a straight and level attitude by making compensatory adjustments of stick and pedal controls. Score is the amount of time the plane was kept straight and level during each of thirty 1-minute test periods separated by 30-second rests.

Measures: factor loadings:

Trials 1-10		Trials 21-30	
Mechanical experience	.28	Speed of arm movement	.49
Response orientation	.33	Response orientation	.27
Control precision	.31	Control precision	.38

II. B. Tests, Cognitive, Perceptual, Psychomotor, and Memory dimensions

RATE OF MOVEMENT TEST

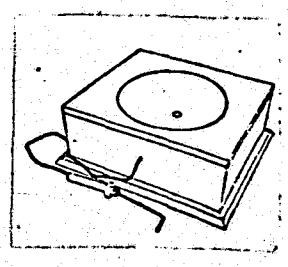
Description: Break the beams between a series of photoelectric cells, one after another, by making scalloped arm-hand movements as rapidly as possible. Score is the number of times the beam is broken in a two-minute trial.

Measures: factor loadings:

Factor	Early loadings	Late loadings
Speed of arm movement	.43	.42

ROTARY PURSUIT

Cost: 50 minutes administration time and the instrument cost.



Description: Subject attempts to keep a prod-stylus in contact with a small metallic target (.75 in. diameter) set in a rapidly revolving disc (10.9 in. diameter). Score is total time on target during each of thirty 30-seconds trials separated by 1-minute rests.

Measures: factor loadings:

Trials 1-8		Trials 25-30	
Speed of arm movement	.28	Speed of arm movement	.47
Control precision	.55	Response orientation	.28
		Control precision	.26

SPEED OF IDENTIFICATION TEST

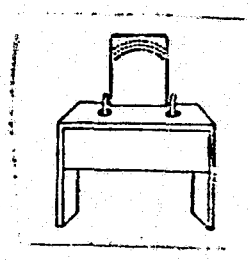
Description: Pictorial items are presented in which the silhouette of an object must be identified when it is rotated and imbedded in a group of similar silhouettes.

Measures: factor loadings:

Factors	Early Loadings	Late Loadings
Speed of arm movement	.27	.16
Visualization	.44	.38
Perceptual speed	.44	.46
Spatial orientation	.21	.37
Response orientation	.27	.29

II. B. Tests, Cognitive, Perceptual, Psychomotor, and Memory dimensions

TWO HAND MATCHING



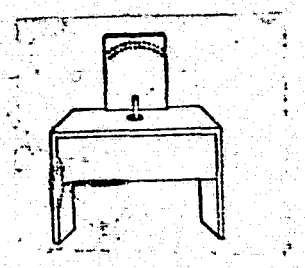
Cost: 50 minutes, individual administration, and instrument cost.

Description: The apparatus is similar to Unidimensional Matching except the red row of stimulus lights has a parallel row of green lights above and below it. The subject must match lights simultaneously in each row of green lights with the red lights through movements of two handles. The movements of each hand sometimes correspond and sometimes are antagonistic to each other and bear a complex relationship to the position of the stimulus lights from setting to setting. Score is the number of simultaneous matchings made and held for .5 seconds during each of thirty 1-minute trials separated by 30-second rests.

Measures: factor loadings:

Trials 1-5		Trials 26-30	
Response orientation	.70	Response orientation	.61
		Spatial orientation	.28

UNIDIMENSIONAL MATCHING



Cost: 20 minutes, individual administration unless electronically recorded, and instrument cost.

Description: The subject is confronted with a panel and two parallel horizontal rows of lights, one red and one green. He attempts to match a stimulus red light with a green light through appropriate movements of a hand-operated control handle. A new light setting is presented after each successful match held for a .5 seconds. Score is the number of matchings for each of fifteen 30-second trials separated by 30-second rests.

Measures: factor loadings:

Trials 1-5		Trials 11-15	
Perceptual speed	.34	Visualization	.34
Control precision	.45	Response orientation	.61

VISUAL PURSUIT TEST

Description: From a series of mazes or irregularly curved lines, the task is to trace each line visually from its beginning to its proper termination point.

II. B. Tests, Cognitive, Perceptual, Psychomotor, and Memory dimensions

Measures: factor loadings:

	Early loading	Late loading
Perceptual speed	.38	.46

155. Fleishman, E. A. Factor structure in relation to task difficulty in psychomotor performance. Educational and Psychological Measurement, 1957, 17, 522-532.

AERIAL ORIENTATION

Measures: factor loading of .61 on Spatial Orientation (200 basic trainee airmen subjects)

DIRECTION CONTROL

Measures: factor loadings of: .34 on Spatial Orientation
.58 on Response Orientation

FORMATION VISUALIZATION

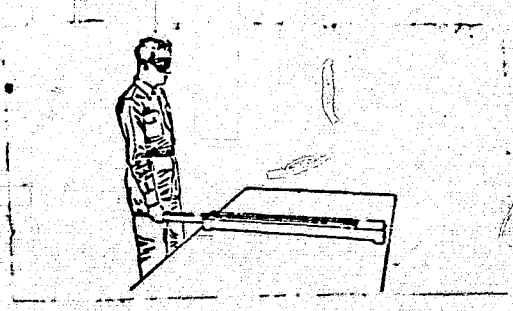
Measures: factor loading of .58 on Visualization

156. Fleishman, E. A. An analysis of positioning movements and static reactions. Journal of Experimental Psychology, 1958, 55, 13-24.

200 basic trainee airmen were used as subjects for this factor analytic study. The reported reliability coefficients were computed from the correlation of odd with even trials corrected to full test length by the Spearman-Brown formula.

CONTROL MOVEMENT R

Description: Move a handle, against friction, through certain designated distances. A stiff arm movement is required for subject to push the control away from his body, as the control extends at right angles to his body at arm's length and by his right side. After preliminary blindfolded trials, with visual inspection of



error, Subject grasps the control. The experimenter then moves the control to a target position where subject's hand remains for 5 seconds. The subject is then required to push the control slowly back to the end stop and then pull it back exactly to the target position. Score is cumulated error in inches for 10 trials.

Data: reliability: .67

Measures: position reproduction: .32

CONTROL MOVEMENT E

Description: Same as Control Movement R except that the apparatus is mounted in an upright position. The subject is required to move against friction in an up-and-down movement; this time he must return his arm halfway back to the target position in 10 trials.

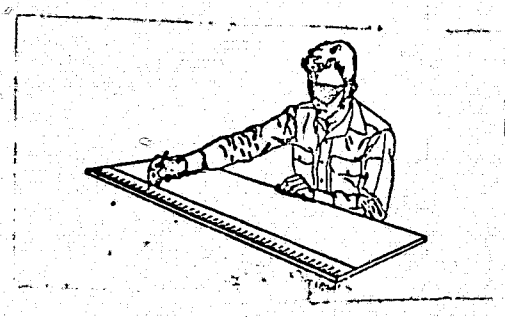


Data: Reliability .70

Measures: Factor loading on position estimation: .48

DIRECTION TRACING

Description: While blindfolded, draw a line, radially, away from the body across a board to designated point on the edge of the board. Before each trial, the pencil is placed at a position on the edge of the board. The subject lifts the pencil back toward his body to a center peg and, on command, moves the pencil across the board to this same position. Score is the cumulated error in units deviation from the target positions in 14 trials.

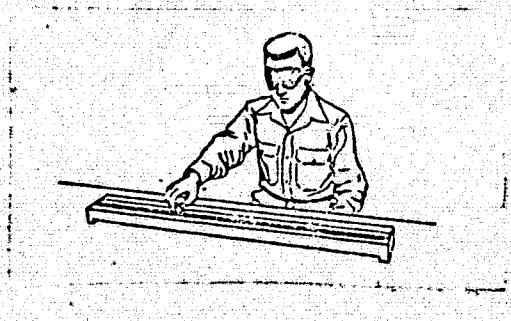


Data: Reliability: .72

Measures: Factor loading on Position reproduction: .39.

KNOB POSITIONING R

Description: Move a knob from side to side through its slot to certain designated positions. The knob is mounted so it can be moved very easily through a groove 36 in. long. The apparatus sits on a table with



the knob up. After preliminary trials with knowledge of results, the seated and blindfolded subject places his hand on the knob. The subject grasps the knob and experimenter moves the knob to a position where subject's hand remains for 5 seconds. The subject is then required to move the knob slowly back to the end stop and then return exactly to the target position. Score is cumulated error in inches for 10 trials.

Data: reliability: .66

Measures: Factor loading on position reproduction: .34.

KNOB POSITIONING E

Description: Same apparatus and scoring as Knob Positioning R. However, after the knob and subject's hand are moved to the target position, he moves to the end stop and estimates a return position halfway back to the target position in 10 trials.

Data: Reliability: .69.

Measures: Factor loading on position estimation: .42.

ROTARY POSITIONING E

Description: Produce an estimated amount of rotary movement. The subject grasps a knob fastened to a pointer which pivots from the center of a circular dial. The knob is fastened to the pointer by a washer-collar arrangement which permits subject's grasp to remain unchanged as his arm moves around the dial. After practice with eyes shut and immediate visual knowledge of results, subject is blindfolded and given a series of trials in which he is told to move the pointer from the standard position to certain estimated positions, as, pointed directly to the top of the circle. Score is cumulated error in terms of total degrees of deviation from the correct positions in 10 trials.



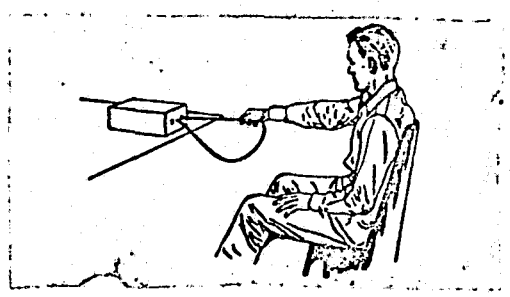
Data: Reliability: .70.

Measures: Factor loading on position estimation: .45.

II. B. Tests, Cognitive, Perceptual, Psychomotor, and Memor dimensions

STEADINESS PRECISION AND STEADINESS TREMOR TESTS

Steadiness Precision test description: Move a long stylus forward, at slightly below shoulder height and at arm's length slowly and steadily away from the body through a long cylindrical pathway. Withdraw, again avoiding hitting the sides. Score is the number of contacts in four trials.



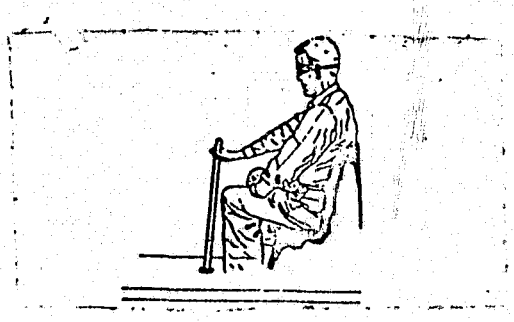
Steadiness Tremor test description: Same apparatus, but the subject merely holds the stylus steadily in the opening trying to avoid hitting the sides. Score is the number of contacts in four 1-minute trials.

Data: Reliabilities: Precision: .88
Tremor: .86

Measures: Factor loadings on Arm-Hand Steadiness: Precision: .56
Tremor: .63

STICK POSITIONING, LATERAL

Description: Reproduce the extent of movement of a stick control in the side-to-side plane. The control utilized is the stick component of the Complex Coordination Test. This test differs from the other extent judgment tests in that the stick movement is not artificially limited to one dimension, but may be moved in the "to-and-from" plane unless the subject controls this. Score is the cumulated error from target positions in 12 trials.



Data: Reliability: .74

Measures: Factor loading on position reproduction: .30

157. Fleishman, E. A. Dimensional analysis of movement reactions. Journal of Experimental Psychology, 1958, 55, 438-453.

II. B. Tests, Cognitive, Perceptual, Psychomotor, and Memory dimensions

A factor analytic study of movement reactions using 204 subjects. The mean test scores are given in the article. The reported test reliabilities are based on correlations of odd and even trials corrected for the full length of the tests except where noted otherwise.

Of central interest is the results of the data analysis for the Multidimensional Pursuit Task given below. This task has been used by Bilodeau (ref. 67) and Jones (ref. 67) for task component studies.

AUDITORY REACTION TIME

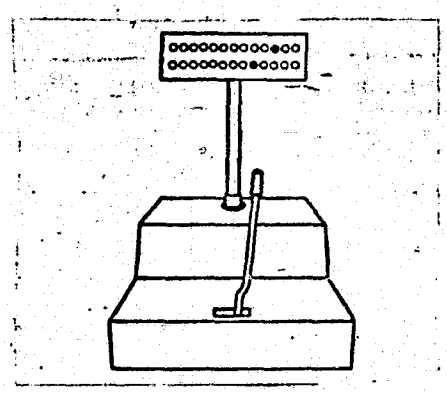
Description: same procedure and scoring as Visual Reaction Time except that the subject responds to a buzzer when it sounds rather then a light.

Measures: factor loading on Reaction Time: .63.

COMPLEX COORDINATION TASK

Data: reliability: .82.

CONTROL ADJUSTMENT

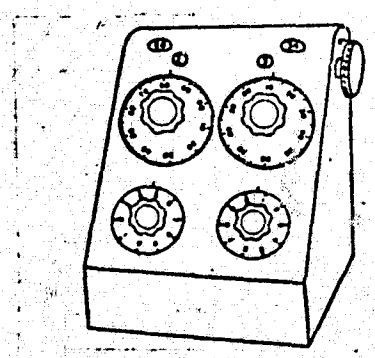


Description: The subject is required to match the position of a red light with a corresponding green light. The position of the lighted green light is controlled by a highly sensitive control stick. A slight movement of the stick to the right displaces the lighted green light to the right and a slight movement of the stick to the left displaces the green light to the left. When subject has matched the two lights and held this position for .5 seconds, the red light moves to a new position and subject proceeds to match it. Score is the number of completed matches in four 1-minute trials separated by 20-second rests.

Measures: factor loadings: control precision: .46

Data: reliability: .91.

DIAL SETTING



Description: The subject is required to set four dials to the exact numbered positions indicated in four stimulus apertures, one of which corresponds to each dial. When all four dials are set exactly according to the indicated numbers, four new stimulus numbers

appear in the apertures. Score is the number of settings completed in three 2 minute trials, separated by 15 second rests.

Measures: Factor loadings: Response orientation: .43
Control precision: .40
Rate control: .27

Data: Reliability: .80.

DISCRIMINATION REACTION TIME-MECHANICAL

Data: Reliability: .75.

JUMP AUDITORY REACTION TIME

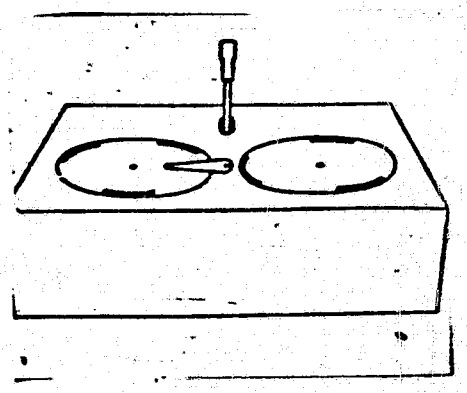
Description: same as the Jump Visual Reaction Time test except response is to a buzzer instead of a light.

Measures: factor loadings of: Reaction time: .64
Speed of arm movement: .44

JUMP VISUAL REACTION TIME

Description: Same procedure and scoring as Visual Reaction Time except subject does not keep his finger on the response button, but keeps it on a cross 6 in. from the response button. He must move his hand to the button as rapidly as possible as each light stimulus appears.

MOTOR JUDGMENT



Description: The subject confronted by two adjacent disks rotating at a constant speed. Each disk has black and white sections on its perimeter. Between these disks is a pointer, whose speed of rotation subject can control. A forward movement of this stick slows the pointer and a backward movement speeds up the pointer. The subject cannot stop the rotation of this pointer completely and he can exert no control over the two rotating disks. The subject is required to manipulate the control stick so as to make as many revolutions of the pointer as possible without crossing the black areas of the rotating disks. To do this properly he must integrate his estimates of the speed of each disk, the pointer, and his own control movements. Score is the ratio of number of pointer revolutions to number of errors (crossings of black areas) during four 1-minute trials separated by 15-second rests.

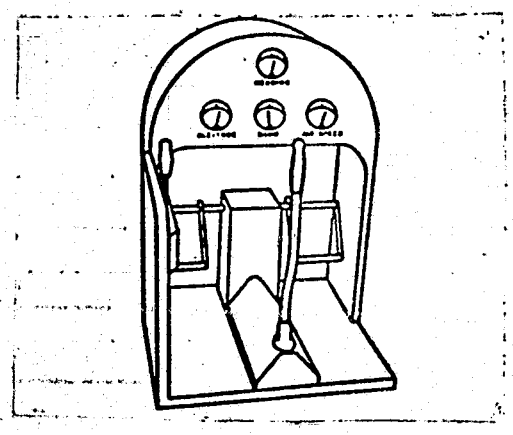
II. B. Tests, Cognitive, Perceptual, Psychomotor, and Memory dimensions

Measures: factor loadings: Control precision: .40
Rate control: .40

Data: reliability: .76.

MULTIDIMENSIONAL PURSUIT

Measures: Equipment allowed the administration of seven tasks which data was factor analyzed along with 24 other task variables on 204 basic trainee airmen. Only one factor was significant on 4 of the 7 tasks, one other factor was significant on one of these:



Factor	Bank & altitude	Bank & heading	Bank & Air Speed	Bank, Heading & Air Speed
Rate Control	.37			
Response Orient	.32	.41	.31	.33

Author concludes "that Response Orientation is involved when the task is complicated by the requirement that two or three controls be operated, but that this factor is not involved in the single component subtasks....these results are independent of the particular control used or combination of controls involved."

Data: reliabilities for the seven tasks ranged from .75 to .96. For the four tasks above the reliabilities are respectively: .90, .95, .96, and .89.

PLANE CONTROL

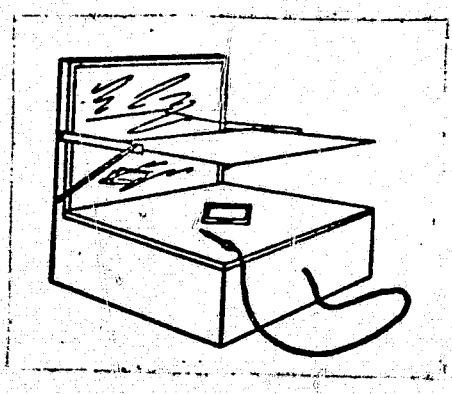
Data: reliability: .88.

Measures: factor loading: .41 Multilimb Coordination

PURSUIT CONFUSION-TIME ON TARGET AND ERRORS

Description:

Time on Target: The subject attempts to keep a stylus on a variable-speed target as it moves through a diamond-shaped slot. The task is complicated by the fact that the entire target area is visible only by mirror-vision. Score is the time on target during four 1-minute test periods separated by 15-second rests.



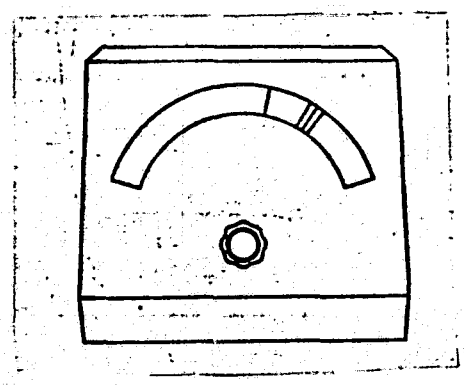
Errors: Same as TOT except the score is the amount of time subject is in contact with the sides of the slot.

Measures: factor loadings:

	Arm hand steadiness	Rate control	Pursuit confusion doublet
TOT	.12	.37	.24
Errors	.36	.19	.31

Data: reliability: TOT: .82
Errors: .84

RATE CONTROL

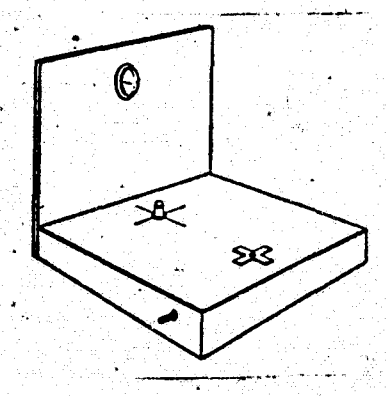


Description: A vertical target line moves back and forth across a curved scale, with frequent changes in direction and rate of movement. The subject attempts to keep a thin pointer in coincidence with this line by adjustive rotary manipulations of a knob control. Score is total time the pointer and target line are in coincidence during four 1-minute trials, separated by 15-second rests.

Measures: factor loadings: Control precision: .30
Reaction time: .29
Rate Control: .30

Data: reliability: .69.

REACTION TIME



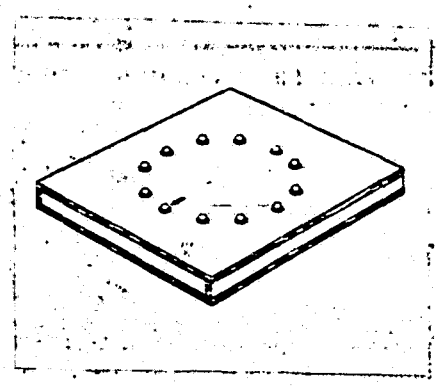
Data and Description: The same instrument is used for the following four tests of reaction time with these associated reliabilities:

VISUAL REACTION TIME	.82
AUDITORY REACTION TIME	.81
JUMP VISUAL REACTION TIME	.83
JUMP AUDITORY REACTION TIME	.84

The above reliabilities are based on test-immediate retest correlations obtained in a previous study.

II. B. Tests, Cognitive, Perceptual, Psychomotor, and Memory dimensions

ROTARY AIMING



Description: The task is to strike at a series of buttons arranged in a circular pattern on a horizontal panel going from one button to the next as rapidly as possible. Score is the number of strikes in four 30-second trials separated by 25-second rests.

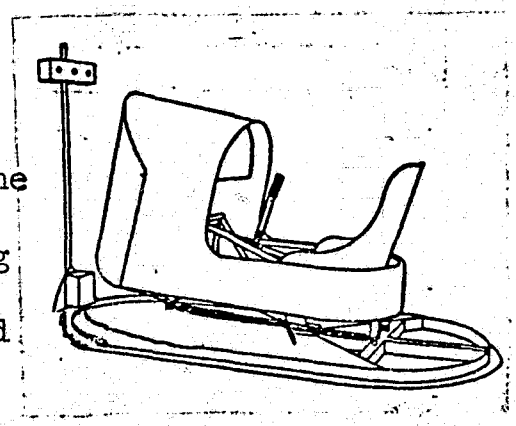
Measures: factor loadings: Speed of arm movement: .38

Data: reliability: .92.

ROTARY PURSUIT

Data: reliability: .81.

RUDDER CONTROL - SINGLE TARGET



Description: The subject sits in a mock airplane cockpit, which he attempts to keep lined up steadily with one of three target lights as they come on in front of him. His own weight throws the seat off balance unless he applies and maintains proper correction by means of foot pedals. During this condition, only the center target was used. Score was the total time the cockpit is held lined up with the center light during three 30-second trials separated by 15-second rests.

Data: reliability: based on average intertrial correlations obtained previously: .70.

Measures: factor loadings:

Multilimb coordination:	.52
Control precision:	.44
Doublet:	.44

RUDDER CONTROL-TRIPLE TARGET

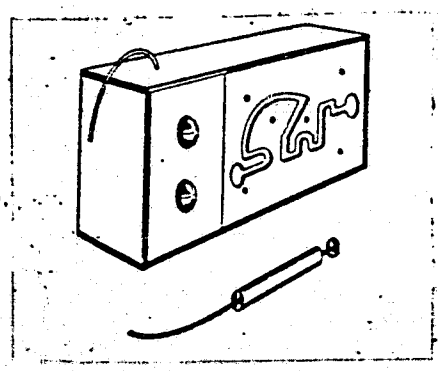
Description: Same apparatus as Rudder Control-Single target, but in this condition subject must utilize appropriate pedal control to shift the cockpit from one light to the other as these come on at random intervals. Score is the total time the cockpit is lined up with the proper light during three 112-second trials separated by 30-second rests.

II. B. Tests, Cognitive, Perceptual, Psychomotor, and Memory dimensions

Data: reliability: based on average intertrial correlations obtained previously: .82.

SINGLE DIMENSION PURSUIT METER

Measures: factor loading on Rate Control: -.06



TRACK TRACING

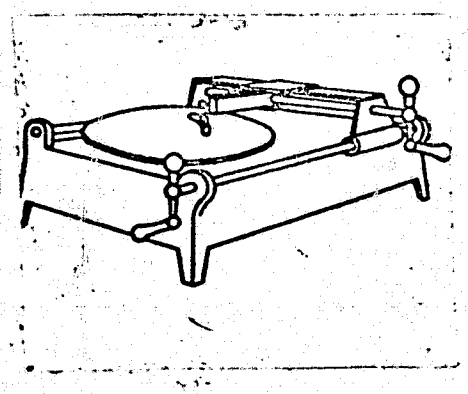
Description: The subject is required to negotiate an irregular slot pattern with a T-shaped stylus held at arms length. Score is the number of errors. (contacts with the back, top and sides of slot) during four attempts. No time limits.

Measures: factor loadings:
control precision: .29
arm-hand steadiness: .50

Data: reliability: .88.

TWO-HAND COORDINATION

Measures: factor loadings:
Multiple limb coordination: .33
Rate Control: .32

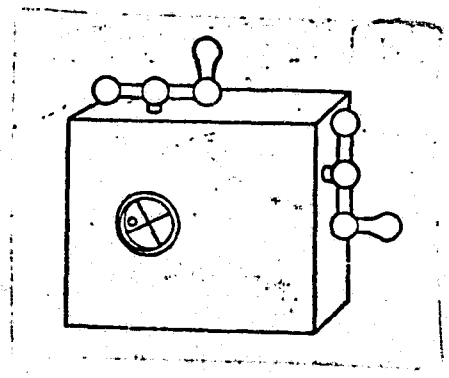


Description: The subject attempts to keep a target-follower on a small target disk as the target moves irregularly and at varying rates. In the present study the target was reduced to a .5 in. diameter. Movement of the target-follower to the right and left is controlled by one latch-type handle; movement to and from is controlled by the other handle. Consequently, simultaneous rotation of both handles moves the follower in any resultant direction. Score was the total time on target during four 1-minute trials separated by 15-sceond rests.

Data: reliability: .80.

TWO-HAND PURSUIT

Description: This is similar to Two-Hand Coordination except this task involves compensatory rather than following pursuit. The subject

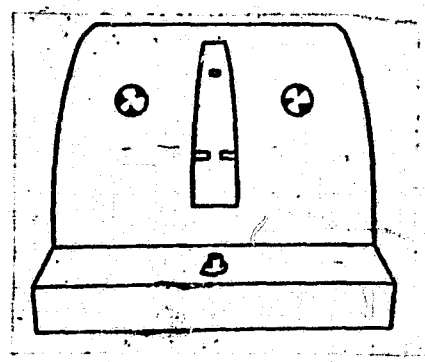


is required to coordinate the movements of two control handles to keep a small target under a cross-hair as it deviates from a null position. Score is the time the target is kept "on target" during four 1-minute trials separated by 15-second rests.

Measures: factor loadings:
arm-hand steadiness: .26
multilimb coordination: .32
rate control: .37

Data: reliability: .83.

VISUAL COINCIDENCE



Description: The subject must react to a thin bar of light which moves from top to bottom behind a curved, translucent vertical screen. When the position of the moving light passes exactly between a pair of adjacent, stationary lights, subject responds by pushing a button. If the reaction of subject occurs at the exact point of coincidence, two red signal lamps at the sides of the screen flash. If subject presses the button too soon or too late, no correct response is recorded (even if subject holds the buttom down). For each of 16 stimulus presentations, the reference lights may appear at different places on the screen and the bar of light may move at different rates. Score is the number of correct responses for 64 stimulus presentations, with a 10-second rest between each series of 16 presentations. Each series of 16 presentations comprised 100 seconds.

Measures: factor loading: response orientation: .36

Data: reliability: .74.

VISUAL REACTION TIME

Description: the subject keeps his finger on a button, depressing it (1/8") as rapidly as possible in response to a single amber light before him. A click provides him with a ready signal before each light stimulus is presented with the fore period (between click and light) varying in a random order from .5 to 1.5 seconds. Score is the cumulated reaction time for a series of 20 reactions.

Measures: factor loading on Reaction time: .56

158. Fleishman, E. A., Abilities at different stages of practice in rotary pursuit performance. Journal of Experimental Psychology, 1960, 60, 162-171.

SINGLE DIMENSION PURSUIT METER

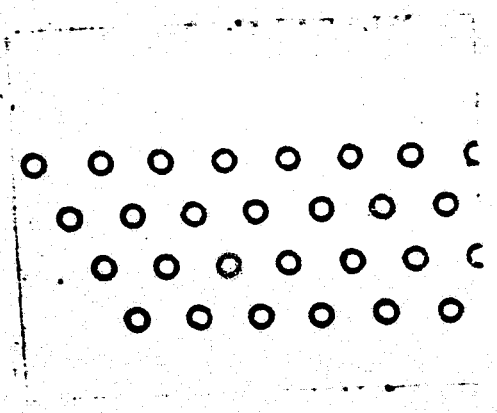
Measures: factor loading on Rate Control: .64

159. Fleishman, E. A., and Ellison, G. D. A factor analysis of fine manipulative tests. Journal of Applied Psychology, 1962, 46, 96-105.

Method: 760 airmen entering three technical schools were administered twelve apparatus and 9 printed fine manipulative tests. The data from the measurement set was factor analyzed.

AIMING TEST

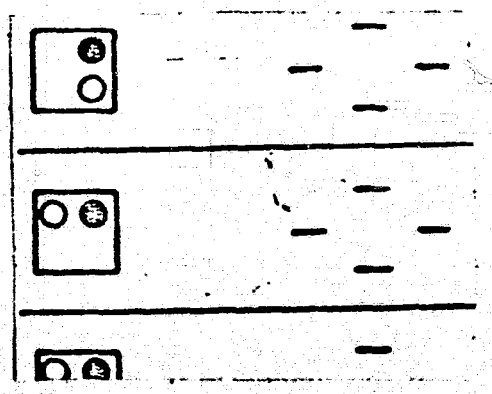
Description: The subject is required to make one dot in each of a series of very small circles (1/8" in diameter), working as fast and accurately as possible. Score is the number of dots correctly placed in 60 seconds.



Measures:	Factor loadings:	
	Wrist-finger speed:	.52
	Finger Dexterity:	.30
	Aiming:	.57

DISCRIMINATION REACTION TIME - PRINTED

Description: This is a printed version of the apparatus Discrimination Reaction Time Test once used by the Air Force. The subject is provided with a series of items. Each item represents a "stimulus setting." There are four possible directional responses to each setting. The examinee goes from item to item as rapidly as possible checking the appropriate response. Score is the number of items completed minus the number of error in 100 seconds.



II. B. Tests, Cognitive, Perceptual, Psychomotor, and Memory dimensions

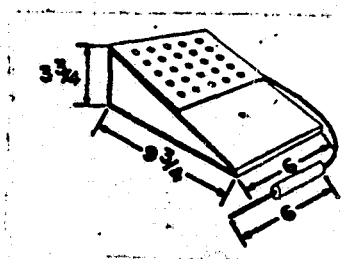
Measures: factor loadings: Wrist-finger speed: .30
Manual dexterity: .34

HAND PRECISION AIMING - CORRECTS

Description: Same procedure as 'Errors' except score is the number of correct responses. A correct count occurs every time the subject strikes through to the lower plate. They were recorded during trials 2, 4, and 6 of six 30-second trials.

Measures: Factor loading: Speed of arm movement: .56

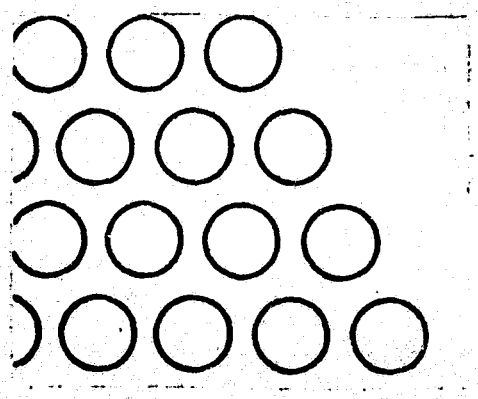
HAND PRECISION AIMING - ERRORS



Description: The subject is seated before a small panel consisting of two parallel metal plates. The plates are tilted toward the subject from the horizontal position. The upper plate contains 25 holes 3/8" in diameter in five rows of five holes each. All holes are equidistant from each other (from center to center). The subject has a small stylus with which he must punch through the holes striking the lower plate. He moves from hole to hole across one row and then across the next as rapidly as possible. He is instructed to aim accurately with each punch but to work as rapidly as possible. Score is the number of error counts recorded. An error count occurs every time the subject strikes the upper plate. Error scores were recorded during trials 1, 3, and 5 of six 30-second trials.

Measures: factor loadings: Speed of arm movement: -.51

LARGE TAPPING TEST

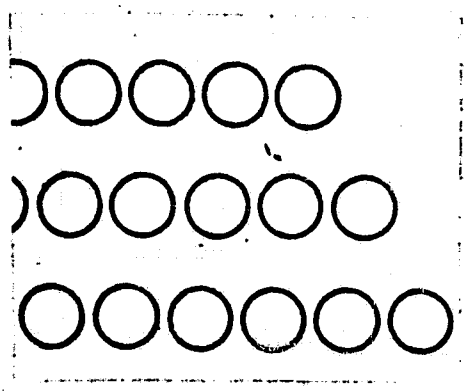


Description: This test is the same as Medium Tapping except circles are $\frac{1}{2}$" in diameter. Score is the number of circles completed in 60 seconds.

Measures: factor loadings:
Wrist-finger speed: .75
Speed of arm movement: .31

MEDIUM TAPPING TEST

Description: The subject is required to make 3 dots in each of a series of circles 3/8" in diameter, working as rapidly as possible. Score is the number of circles completed correctly in 30 seconds.

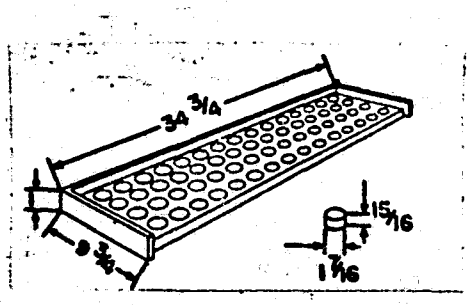


Measures: factor loadings:
Wrist-finger speed: .77
Speed of arm movement: .28

MINNESOTA RATE OF MANIPULATION

Description:

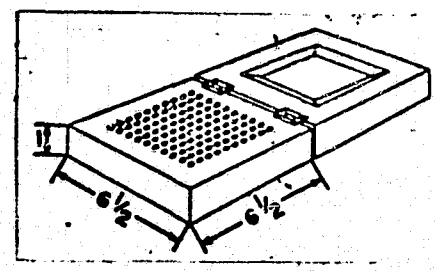
Placing: The subject is required to place 60 cylindrical blocks in the proper holes as rapidly as possible. Score is the number of blocks placed during two 45-second trials. (Note: the modification of this test from a "work limit" to a "time limit" test is described in ref. 153).



Turning: The subject is required to remove the blocks from the holes with one hand, turning them over with the other hand, and replace them in the same holes, moving from block to block as rapidly as possible. Score is the number of blocks turned in two 35-second trials. (See note above re: time limit)

O'CONNOR FINGER DEXTERITY

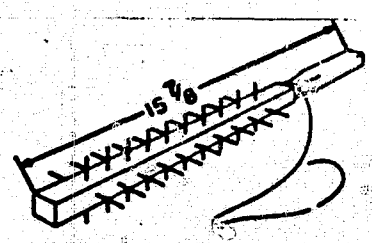
Description: The subject is required to pick up three small pins at a time from a tray of pins with the preferred hand and place them three at a time in a small hole. He must fill a series of small holes in this manner as fast as possible. Score is the number of pins placed in 5 minutes.



Measures: factor loading: Finger dexterity: .59

PIN STICK TEST

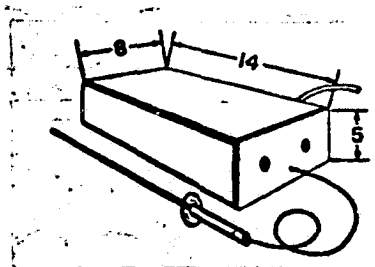
Description: The subject holds a rod containing four rows of pins on each of four sides. He is required to take the thread attached to the bottom of the rod and to make one loop around each pin as rapidly as possible going from pin to pin, up and then down the stick. Score is the number of pins threaded in four 15-second trials.



II. B. Tests, Cognitive, Perceptual, Psychomotor, and Memory dimensions

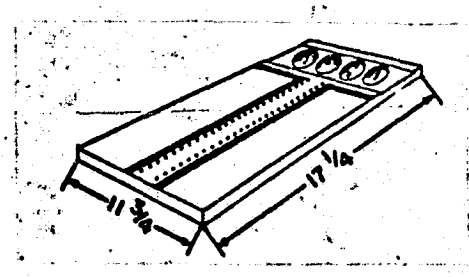
Measures: factor loading: finger dexterity: .34

PRECISION-STEADINESS TEST



Description: The subject is seated before a long rectangular box-like apparatus containing two openings. Each opening is the entrance to a straight passageway which the examinee must negotiate with a long stylus. He moves the stylus forward at slightly below shoulder height and at arm's length. He must move the stylus slowly and steadily away from his body, trying not to hit the side of the cylindrical passage. As he reaches the end of the passage, he strikes a contact point and withdraws the stylus, again trying to avoid hitting any part of the passageway. He then negotiates the second passageway. Two complete negotiations constitute a trial. Score is the number of seconds in contact with the sides of the passage during six trials.

PURDUE PEGBOARD



Description:

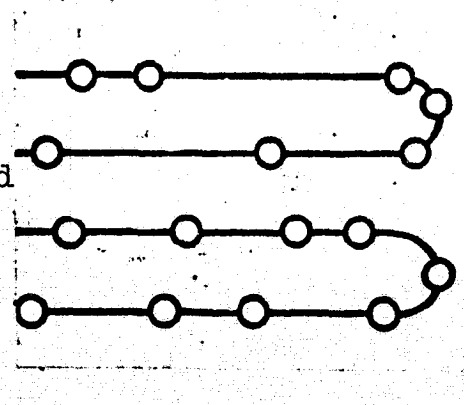
Right hand: The subject is required to place a number of small pegs individually in a series of small holes as rapidly as possible with the right hand. Score is the number of pegs placed in two 30-second trials.

Left hand: This test is the same as the right hand procedure.

Both hands: The subject is required to pick up two pins at a time, one with each hand from different trays and place them simultaneously in two different holes. Score is the number of pegs placed in two 30-second trials.

Assembly: The subject is required to make as many completed peg-washer-collar-washer assemblies as possible in the time allowed. Score is the number of assembly components completed in two 60-second trials.

PURSUIT AIMING I TEST



Description: The subject is required to follow a pattern of small circles (3/16" in diameter) placing one dot in each circle around the pattern. Score is the number of dots placed in 30 seconds.

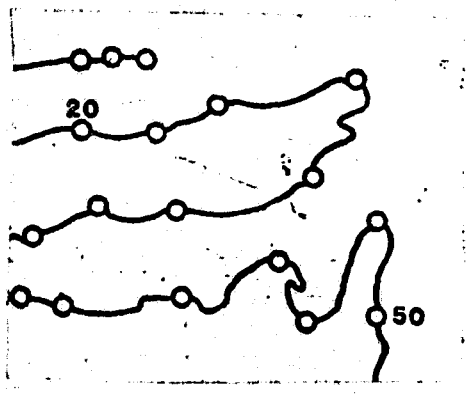
Measures: factor loadings:
wrist-finger speed: .52
finger dexterity: .27
aiming: .63

⊕3

II. B. Tests, Cognitive, Perceptual, Psychomotor, and Memory dimensions

PURSUIT AIMING II TEST

Description: This test is the same as Pursuit Aiming I except the pattern is more difficult and the circles are small (1/8" in diameter). Score is the number of dots placed in 60 seconds.

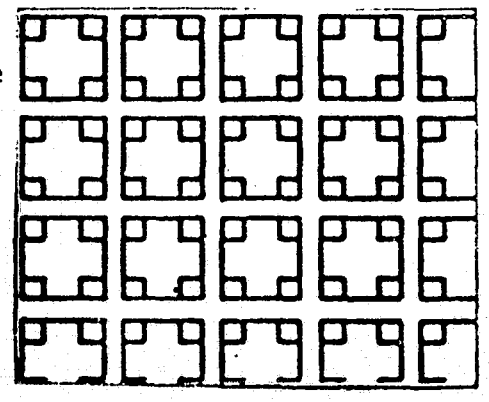


Measures: factor loadings:

wrist-finger speed:	.54
finger dexterity:	.28
aiming:	.63

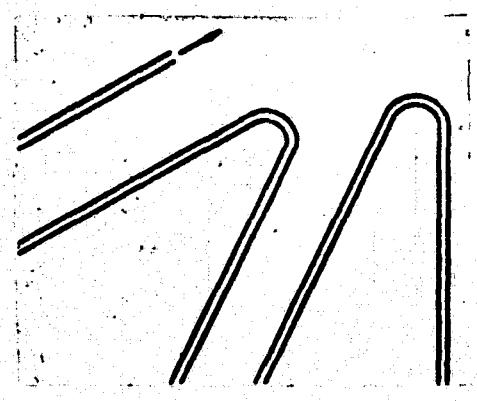
SQUARE MARKING TEST

Description: the subject is required to place a series of X marks precisely inside a series of small (1/8") squares. Score is the number of complete squares in 60 seconds.



STEADINESS TEST (Printed)

Description: The subject must trace slowly between a pair of narrowly separated lines (1/16") which form a pattern. Score is the number of segments negotiated without touching the lines.

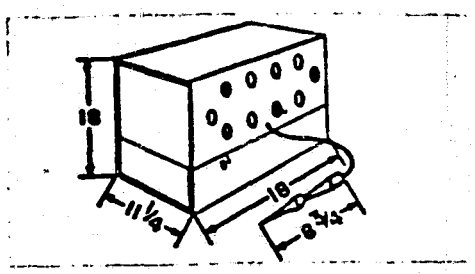


TEN TARGET AIMING - CORRECTS

Description: Same apparatus as Ten Target Aiming - Errors, except correct counts are scored each time the examinee hits precisely within the target area in each hole. Correct scores were recorded during trials 2, 4, and 6 of six 30-second trials.

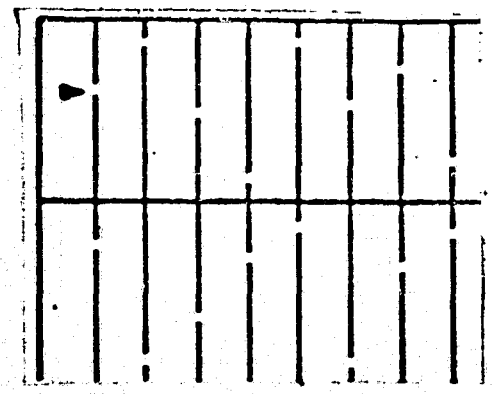
II. B. Tests, Cognitive, Perceptual, Psychomotor, and Memory dimensions

TEN TARGET AIMING - ERRORS



Description: The subject is seated before a panel containing 10 holes at equal intervals in an elliptoid pattern. Behind each hole can be seen a circular target. These targets vary in size from hole to hole. The examinee is required to strike at these targets with a stylus, moving from target to target around the pattern of targets in a clockwise direction. He makes only one strike at a time in each hole as he moves around the pattern. He is instructed that both speed and accuracy count and that he must try to hit as many targets as possible from target to target. Score is the number of errors which are recorded each time the subject strikes the outside of a hole or inside around the target area. Error scores were recorded only during Trials 1, 3, and 5 of six 30-second trials.

TRACING TEST



Description: The subject is required to trace through a series of small openings (1/16") in a maze pattern. He must work as quickly as possible trying not to allow his pencil mark to touch any of the maze lines. Each touch is counted as an error. Score is the number of openings negotiated minus the number of errors in 50 seconds.

160. Fleishman, E. A., and Hempel, W. E. Factorial analysis of complex pyschomotor performance USAF Personnel and Training Research Center, Research Bulletin No. 54-12, 1954. (AD 34 411)

COMPLEX MOVEMENTS

Measures: factor loadings of: .32 on Visualization
.40 on Integration

COORDINATE MOVEMENTS

Measures: .36 on Spatial Orientation
.44 on Integration

DIRECTION CONTROL
Measures: factor loadings of: .44 on Visualization
.39 on Spatial Orientation

DIRECTIONAL CONTROL
Measures: factor loadings of: .38 on Spatial Orientation
.34 on Visualization
.28 on Integration

SINGLE DIMENSION PURSUIT METER
Measures: factor loading on Rate Control: .55

161. Fleishman, E. A., and Hempel, W. E. Changes in factor structure of a complex psychomotor test as a function of practice. Psychometrika, 1954, 19, 239-252. Also available as HRRC Research Bulletin, 53-68. (AD 25624).

COMPLEX COORDINATION TASK

Method: complex coordination task was performed for 64 trials over two days by 197 basic airmen. Eight segments of 5 trials each were factor analyzed along with 18 reference tests.

Results: The factor loadings indicated that initial performance is dominated by nonmotor factors, while motor factors dominate well practiced performance:

Trials	Control Prec **	Spd of arm Movement	Spatial orient	Visualization	Mechanical exp	Task Specif
1-5	.48	.10	.39	.38	.28	.24
60-64	.47	.37	.10	.10	.18	.62

Authors comment: "...the tests used in the Aircrew Classification Battery were, without exception, designed to predict the success of candidates in-training for the specialty to which they were designed....rather than attempts to predict the terminal levels of proficiency."

**the factor names given are those currently in use.

II. B. Tests, Cognitive, Perceptual, Psychomotor, and Memory dimensions

SPATIAL ORIENTATION TEST

Measures: factor loadings of: .35 on Spatial Orientation
.45 on Perceptual Speed

162. Fleishman, E. A., and Hempel, W. E. A factor analysis of dexterity tests. Personnel Psychology, 1954, 7, 15-32.

A factor analytic study using airmen as subjects. Unless noted otherwise, the test reliabilities are split-half reliability estimates based on separately timed trials, corrected for the length of the total test as given in this study.

MARKING ACCURACY TEST

Description: Subject is provided with a standard IBM marking sheet and is required to mark in the slot circled for each item going from item to item as quickly as possible. Two 40-second trials. Score is corrects minus errors.

Data: reliability: .91.

Measures: factor loadings: Manual dexterity: .28
Aiming: .52

MINNESOTA RATE OF MANIPULATION

Data: placing: .87
turning: .79

Measures: factor loadings:

	Finger dext	Manual dext	Wrist-finger spd	Positioning
Placing	.29	.42		.43
Turning	.39	.49	.31	

O'CONNOR FINGER DEXTERITY

Data: test-retest reliability estimate based on airman samples: .76

Measures: factor loading: finger dexterity: .55

PIN STICK TEST

Data: reliability: .77

II. B. Tests, Cognitive, Perceptual, Psychomotor, and Memory dimensions

Measures: Factor loadings: Finger dexterity: .25
Wrist-finger speed: .50

PURDUE PEGBOARD

Data: test-retest reliability estimates based on airman samples:

Right hand	.70
Left hand	.68
Both hands	.70
Assembly	.74

Measures: Factor loadings:

	Finger dexterity	Positioning	Manual dexterity
Right hand:	.46	.38	
Left hand:	.62		
Both hands:	.61		
Assembly:	.57		.32

SANTA ANA DEXTERITY

Description: Subject is presented with a pegboard having 48 pegs in squareholes. The pegs have square bottom pieces and larger round tops. Half of each round top is painted blue and the other half is painted yellow. When the board is presented to the subject all pegs have the same colored side facing him. The subject lifts each peg from its hole, turns it 180° clockwise and resets it in its hole moving from peg to peg as rapidly as possible. Two 35-second trials. Score is the number of pegs rotated.

Data: reliability: .91.

Measures: factor loadings: Manual dexterity: .45
Wrist-finger speed: .33

SQUARE MARKING

Data: reliability: .92.

Measures: factor loadings: Aiming: .55.

TAPPING, LARGE

Data: reliability: .94.

Description: same as Tapping, Small except circles are 7/16" in size.

Measures: factor loadings: Manual dexterity: .28
Wrist-finger speed: .43
Aiming: .33

TAPPING, SMALL

Description: Subject is required to place one dot in a number of 1/8" circles. One 60-second trial. Score is the number of circles dotted correctly.

Data: reliability: .89.

Measures: factor loadings: Wrist-finger speed: .42
Aiming: .54

TRACING

Data: reliability: .85

Measures: factor loadings: Aiming: .39
Positioning: .27

163. Fleishman, E. A., and Hempel, W. E. The relation between abilities and improvement with practice in a visual discrimination reaction test. Journal of Experimental Psychology, 1955, 49, 301-312.

WORD KNOWLEDGE (VOCABULARY)

Measures: factor loading of .78 on Verbal Comprehension

164. Fleishman, E. A., and Rich, S. Role of kinesthetic and spatial-visual abilities in perceptual-motor learning. Journal of Experimental Psychology, 1963, 66, 6-11.

KINESTHETIC DISCRIMINATION, SPATIAL-VISUAL ABILITIES AND PSYCHOMOTOR LEARNING

Subjects: 40 college males

II. B. Tests, Cognitive, Perceptual, Psychomotor, and Memory dimensions

Method: Three tests were administered to the subjects: Aerial Orientation Test, a test of Spatial Orientation; a Kinesthetic Discrimination Measure: and 40 one-minute trials on the criterion task, Two-Hand Coordination.

Results: the test scores were correlated successively with ten blocks of four one-minute trials. Aerial Orientation correlations steadily decreased from .36 (significant at $p<.01$) on the first block to .01 on the last block. Kinesthetic Discrimination correlations increased from .03 on the first block to .40 on the last block (significant at $p<.01$). The multiple R for overall criterion performance was .73.

KINESTHETIC DISCRIMINATION

Description: Discrimination was measured by determination of the Difference Limen for a set of identically sized weights weighing 100, 102, 104, 106, 108, 110 and 112 grams. The method of limits was used with each subject receiving 24 pairs of weights. The standard was the 106 gram weight.

Data: 24 hour test-retest reliability was .85.

165. Frederiksen, J.R. The role of cognitive factors in the recognition of ambiguous visuql stimuli. Educational Testing Service RD-65-23 and ONR Tech Report, Office of Naval Research Contract Nonr 1858-(15), Project Designation NR 150-088, and Natl Science Foundation Grant G-22889. Princeton University, Princeton, N. J., July 1965. (AD 473580, limited)

COGNITIVE FACTORS AND VISUAL TASK

Subjects: 46 college students.

Method: Visual Recognition Task: 15 copies each of 20 color slides of common scenes were made at different stages of foucs. The focus ranged from full focus to maximum blur. Subjects were shown the 20 slides at the 15 focus levels during the first testing session of $2\frac{1}{2}$ hours. At the second test session subjects took 13 factor tests covering five abilities. Test scores were factor analyzed. The criterion variables

or Visual Recognition Task scores: (1) recognition point, (2) number of hypotheses made, (3) confidence about early hypotheses.

Results: the major results can best be given by a partial reproduction of the author's Table 8 (p. 35) giving the correlation between key variables.

Abilities: Criteria	Visualization	Speed of Closure	Spatial Scanning
Recognition Point	.55	-.50	-.36
Number of Hypotheses	-.34	.46	.03
Confidence Rating	-.15	.55	.02

The correlations given above are averages over the 15 pictures. The loadings of the criterion variables on the ability factors differed markedly from picture to picture; not in direction but rather in amount.(possibly suggesting use of abilities may be determined, in part, by pictorial content?)

The results of the factor analysis are as follows (orthogonal factor loadings):

Test	Reliability*	Spatial Scanning	Flex. of Clo.	Visual	Spatial Orient	Spd of Closure
Choosing	.77	.65	**		.41	
Maze Tracing	.94	.52				.39
Copying	.82	.30	.61	.34	.28	
Hidden Figures	.72		.40			
Hidden Patterns	.87	.51	.44	.28		.30
Form Board	.81	.39	.53	.45	.42	
Paper Folding	.84	.33		.56	.34	
Surface Development	.90	.48		.48	.46	
Card Rotation	.80		.43		.53	
Cube Comparisons	.84	.30	.27	.32	.61	
Concealed Words	.71			.46		.28
Gestalt Completion	.69					.49
Map Planning	.79	.29	.44	.48		.37

*Reliabilities are two month test-retest.
**Only factor loadings of .27 or more are given.

II. B. Tests, Cognitive, Perceptual, Psychomotor, and Memory dimensions

166. Frederiksen, J. R. A study of perceptual recognition in two sense modalities. RB-66-32, Office of Naval Research Contracts Nonr/1858-(15) and Nonr 2214-(00) and US Public Health Service Research Grant 1 P01 HD 01762-01. Educational Testing Service, Princeton, N. J., June 1966. (Author currently at Brandeis Univ. Waltham, Mass.)

COGNITIVE AND PERCEPTUAL FACTORS RELATED TO VISUAL AND AUDITORY RECOGNITION

Summary adapted from the author's abstract:

The adverse effect of early exposure to ambiguity upon subsequent recognition of ambiguous stimuli was studied in the visual and autitory sense modalities. The Visual Recognition Task was the same used in the previous report (Frederiksen, 1965). The Auditory Recognition Test contained a series of words to be recognized by the Subjects. The words were rendered ambiguous by masking them with a mixture of other speech sounds. Ambiguity was reduced by the gradual reduction of the decibel level of the mask. Both tasks, therefore, presented the subject with a situation in which his erroneous initial hypotheses about the nature of the stimulus were gradually disconfirmed as a function of ambiguity reduction.

The subjects were divided into two groups, each exposed to a different overall range of ambiguity. Subjects in the second treatment group began each auditory and visual test item at a later state of ambiguity than did subjects in the first group. The subject population consisted of 145 (N_1 = 85, N_2 = 60) male graduate and undergraduate paid volunteer college students.

A hypothesis that earlier recognition of the stimuli would occur in the second group was "strongly confirmed for both sense modalities."

Perception in the two modalities did not correlate; this was a result of the differing factor contribution to the two types of performances.

The study also investigated the relations between perceptual recognition and a number of factor-analytically derived measures of flexibility and perception. A general factor, called Cognitive Flexibility-Rigidity, "was found to be strongly implicated as a factor in the recognition of auditory stimuli, and less strongly in visual recognition." ..."The most interesting finding here (with respect to perceptual recognition) was a relation between Flexibility of Closure and the two recognition tasks. This factor, while being highly correlated with Cognitive Flexibility, contributed to late,

rather than early, auditory and visual recognition. This result suggested that what Witkin calls "an ability to overcome embeddedness" may facilitate the formation of possibly erroneous hypotheses in auditory recognition, and that a "global" interpretation of a blurred image facilitates its subsequent recognition." The regression beta-weights for prediction of perception in the two modalities under the two range conditions from the set of 10 factors are reported.

Criterion recognition tasks: the author presents the instructions for both tasks, complete description and response data for the auditory test, and the modifications of the Visual Task which increased its test-retest reliability.

Predictor tests; 27 tests were administered. The maximum likelihood estimates (Joreskog's for fitting a simple structure hypothesis) of factor loadings on 23 of these tests is presented below along with the test reliabilities. These figures have been taken from the author's Tables 4 and 6, eliminating factor loadings below .27. The mean scores, SD's, range, and normality of distributions are also presented in the report. Three of the tests which yielded high loadings of the Cognitive Flexibility-Rigidity factor are presented in Appendix B of the report and are described briefly here:

SIGN CHANGES: requires the subject to perform "overlearned" behavior, in an unconventional manner. Consists of arithmetic problems where the meaning of the signs has been changed. One minute is allowed.

REVERSED READING: reading must be performed in an unconventional manner. Consists of sentences placed in the normal order but the letter order for the words reversed. One minute is allowed.

RESOURCEFUL ARITHMETIC: a set of 20 problems each of which could either be computed in detail, summary computations only, or, in some cases, quickly evaluated without computation. The number of problems solved within the time limit depend on which of the above approaches was used.

Test	Spd of Clos.	Vis.	Ideational Fluency	Flex. of Closure	Spatial Orientation	Cog. Flex.-Rigid	Semantic Spontaneous Flexibility
Concealed Words	.65						
*Gestalt Completion	.46	.40				-.41	
Form Board		.89					
Paper Folding		.93					
*Surface Development		.90					
Topics			.67				
Thing Categories			.67			.27	.36
Hidden Figures				.66			
Hidden Patterns				.70			
Copying				.73			
Card Rotations					.42		
Cube Comparisons					.80		
Sign Changes						.73	
Reversed Reading						.63	
Resourceful Arith.						.69	
Utility Test		1.04					.72
Object Naming		.50					.43
*Advanced Vocabulary							
Maze Tracing							
Choosing a Path		.47					
Map Planning							
Auditory Number Span							
Auditory Letter Span							

*These tests were not sufficiently difficult, i.e., the distributions were skewed.

This table is continued on page 126 ref. 166 (Frederiksen, 1966)

Test	Verbal Ability	Spatial Scanning	Memory Span	Reliability
Concealed Words				.75
*Gestalt Completion				.77
Form Board				.81
Paper Folding				.86
*Surface Development				.88
Topics				.90
Thing Categories				.67
Hidden Figures				.76
Hidden Patterns				.91
Copying				.89
Card Rotations		.35		.85
Cube Comparisons				.77
Sign Changes				.85
Reversed Reading	.49			.94
Resourceful Arith.				.86
Utility Test				.74
Object Naming				.40
*Advanced Vocabulary	.52			.83
Maze Tracing		.71		.92
Choosing a Path		.27		.78
Map Planning		.71	.32	.75
Auditory Number Span			.91	.80
Auditory Letter Span			.75	.73

*These tests were not sufficiently difficult, i.e., the distributions were skewed.

This table was continued from page 125 ref. 166 (Frederiksen, 1966)

167. Fuerst, K. and Zubek, J. P. Effects of sensory and perceptual deprivation on a battery of open-ended cognitive tasks. Dept. of Psychology, Manitoba University, Winnipeg, Man., Canada. (AD 669 409). Also available in Canadian Journal of Psychology, Review, Canadian Psychology, 1968, 22 (2), 122-130.

OPEN-ENDED TASKS AND SENSORY, PERCEPTUAL DEPRIVATION

Subjects: Perceptual deprivation condition: 24 Experimental subjects (18 successful completions) and 18 Controls. Sensory deprivation condition: 19 Experimental subjects (18 successful completions) and 18 Controls. All were young male college students.

Method: Two separate experiments were run, one with perceptual deprivation (diffused light and white noise) and one with sensory deprivation (darkness and silence). Both experiments consisted of four days in an isolation chamber. The subjects were tested prior to entering the chamber and again on the third day of isolation, using alternate forms of Guilford's Battery for Creative Thinking.

Results: There was a non-significant trend under both deprivation conditions for Experimental subjects to do worse on the test battery. The quitters had the lowest scores but the difference was not significant. When the data for both conditions was pooled the experimental subjects performed worse than the Controls, sig. at $p < .01$, on the Ideational Fluency Test.

The results did not, therefore, support the hypothesis that open-ended tests would be maximally affected by deprivation. Authors suggest that these results and other researches indicate that the "critical period" for performance under deprivation is between one and two days.

168. French, J. W. Ekstrom, Ruth B. and Price, L. A. Manual for kit of reference tests for cognitive factors (Revised 1963). ONR contract Nonr-2214 (00), Project designation NR 151-174. Princeton, N.J.: Educational Testing Service, June 1963. (AD 410-915)

II. B. Tests, Cognitive, Perceptual, Psychomotor, and Memory dimensions

KIT OF REFERENCE TESTS FOR COGNITIVE FACTORS

This manual contains keys for all of the tests described and references to the studies in which the factor has been found. Further details on how to obtain copies of these reference tests are included in the manual. (Also see Buros' Sixth Mental Measurement Yearbook, Ref. 146)

ADDITION TEST

Description: Adapted from numerous tests of this factor. This is a speed test of the addition of sets of three 1-or 2-digit numbers. Copyright ETS.

Length of each part: 60 items, 2 minutes , suitable for grades 6-16

Measures: Number Facility

ADVANCED VOCABULARY I

Description: Adapted from a Cooperative Vocabulary Test. This is a 5-choice synonym test consisting mainly of difficult items. Copyright ETS.

Length of each part: 18 items, 4 minutes, suitable for grades 11-16

Measures: Verbal Comprehension

ADVANCED VOCABULARY II

Description: Adapted from a test by J. B. Carroll. This is a 4-choice synonym test consisting mainly of difficult items. Copyright ETS.

Length of each part: 18 items, 4 minutes, suitable for grades 11-16

Measures: Verbal Comprehension

ALTERNATE USES

Description: A test developed in Guilford's project. The task is to list different uses for common objects. Copyright Sheridan Supply Co.

Length of each of 3 parts: 3 objects, 4 minutes (a 12-item form is also available), suitable for grades 6-16

Measures: Flexibility

II. B. Tests, Cognitive, Perceptual, Psychomotor, and Memory dimensions

APPARATUS TEST

Description: A test developed in Guilford's project. The subject is asked to suggest two improvements for each common appliance named. Copyright J. P. Guilford.

Length of each part: 10 appliances, 7 minutes, suitable for grades 8-16

Measures: Sensitivity to Problems

ASSOCIATIONAL FLUENCY I

Description: A test by Christensen and Guilford in which the subject is asked to write as many synonyms as possible for each of 2 words given in each part. The score is the number of words written that are reasonably similar in meaning to the stimulus word. Copyright Sheridan Supply Co.

Length of each part: 2 given words, 2 minutes, suitable for grades 6-16

Measures: Associational Fluency

ASSOCIATIONS IV

Description: A test by J. P. Guilford. The task is to produce a word that is associated with both the 2 given words but which has a different meaning in its relationship to each of them. Copyright J. P. Guilford.

Length of each part: 15 items, 7 minutes, suitable for grades 6-16

Measures: Associational Fluency

AUDITORY NUMBER SPAN TEST

Description: Test developed by Kelley. This is a conventional digit-span test with digits in series of varying length being read at a speed of one second per digit. The examinees must not start writing until the series has been completed. Each item is separately administered allowing test to be scored in any way that seems desirable.

Note: The test items to be read by the examiner are contained in the key to this test at the end of this manual. Copyright ETS.

Length: 24 series, about 10 minutes. Suitable for grades 6-16.

Measures: Memory Span

Note: this test is also called the Number Span Test I (Auditory).

CARD ROTATIONS TEST

Description: Suggested by Thurstone's Cards. Each item gives a drawing of a card cut into an irregular shape. To its right are six other drawings of the same card sometimes turned over onto its other side. The subject indicates which ones show the card not turned over. Copyright ETS.

Length of each part: 14 items, 4 minutes, suitable for grades 8-16

Measures: Spatial Orientation

CHOOSING A PATH

Description: Adapted from AAF Printed Classification Test. Each item consists of a network of lines as in an electrical-circuit diagram having many intersecting and intermeshed wires with several sets of terminals. The task is to trace the lines and to determine for which pair of terminals, marked S (start) and F (finish), there is a complete circuit through a circle at the top. There is some orderliness in the layout to encourage comprehension of the pattern by scanning rather than visual pursuit of lines. Copyright ETS.

Length of each part: 15 items, 7 minutes, suitable for grades 6-16

Measures: Spatial Scanning

CONCEALED WORDS TEST

Description: A test suggested by Thurstone's Mutilated Words. Words are presented with parts of each letter missing. The subject is to write out the full word in an adjacent space. Copyright ETS.

Length of each part: 25 words, 3 minutes, suitable for grades 6-16

Measures: Speed of Closure

CONSEQUENCES (remote)

Description: The task is to list the consequences of certain hypothetical situations. The score is the number of indirect or remote consequences written. Copyright Sheridan Supply Co.

Length of each part: 2 minutes for each of 10 hypothetical situations suitable for grades 10-16

Measures: Originality

CONTROLLED ASSOCIATIONS TEST

Description: A test adapted from Thurstone's test of this name. The task is to write as many synonyms as possible (up to 12) for each of 4 words. The score is the number of words written that are related to the stimulus word. Copyright ETS.

Length of each part: 4 given words, 6 minutes, suitable for grades 6-16

Measures: Word Fluency

COPYING TEST

Description: A test suggested by a sub-test of this name in MacQuarrie's Test for Mechanical Ability and by Thurstone's adaptation of it. Each item consists of a four-line geometrical figure and a square matrix of dots. The task is to copy the figure onto the dots. Copyright ETS.

Length of each part: 32 figures, 3 minutes, suitable for grades 6-16

Measures: Flexibility of Closure

CUBE COMPARISONS TEST

Description: Adapted from Thurstone's Cubes. Each item presents two drawings of a cube. Assuming no cube can have two faces alike, the subject is to indicate which items present drawings that can be of the same cube and which ones present drawings that cannot be of the same cube. Copyright ETS.

Length of each part: 21 items, 3 minutes, suitable for grades 8-16

Measures: Spatial Orientation

DIGIT SPAN - VISUAL

Description: Test developed by Kelley. The items in this test are parallel with those for Auditory Number Span Test, but they are presented by having each digit printed on a large card, and by flipping over one card per second or otherwise exposing one digit per second for the examinees to see. It is important that the digits be large enough and so placed as to be clearly visible to all subjects.

Note: It will be necessary for users to produce their own digit cards. A suitable set of digits appears as the Key to this test at the end of this manual. Copyright ETS.

Length: 24 series, about 10 minutes, suitable for grades 6-16

Measures: Memory Span

DIVISION TEST

Description: Adapted from numerous tests of this factor. This is a speed test in dividing 2- or 3-digit numbers by single-digit numbers. Copyright ETS.

Length of each part: 60 items, 2 minutes

Measures: Number facility

ELECTRICAL INFORMATION

Description: This is a factual information test in practical electrical and simple electronics problems of the kind that might be encountered in do-it-yourself repairs. Each items offers 4 alternative responses. Copyright ETS.

Length of each part: 15 items, 6 minutes, suitable for grades 8-16

Measures: Mechanical Knowledge

ESTIMATION OF LENGTH TEST

Description: Adapted from AAF Printed Classification Tests. Each item consists of lines $\frac{1}{2}$ to $1\frac{1}{2}$ inches in length oriented in different directions. This is to be compared with a set of 5 pairs of companion lines at the center of the page. The test lines may be as long as or twice as long as the companion lines. This is a speeded test. Copyright ETS.

Length of each part: 40 items, 3 minutes, suitable for grades 6-16

Measures: Length Estimation

EXPRESSIONAL FLUENCY

Description: A test developed in Guilford's project. The task is to write as many 4 word sentences as possible when the first letter

of each word is given. This test is similar to Carroll's Letter-Star Test. Copyright Sheridan Supply Co.

Length: 4 parts consisting of a set of 4 letters, 2 minutes for each part, suitable for grades 8-16

Measures: Expressional Fluency

FIGURE CLASSIFICATION

Description: This test is an adaptation of a North Carolina version of Thurstone's test of the same name. Each item presents 2 or 3 groups each containing 3 geometrical figures that are alike in accordance with some rule. The second row of each item contains 8 test figures. The task is to discover the rules and assign each test figure to one of the groups. Copyright ETS.

Length of each part: 14 items each with 8 test figures, 8 minutes Suitable for grades 8-16

Measures: Induction

FINDING A's TEST

Description: Adapted from Thurstone's Letter "A". In each column of 41 words, the task is to check the 5 words having the letter "a". The score is the number of words correctly checked. Copyright ETS.

Length of each part: 1,025 words, 2 minutes, suitable for grades 6-16

Measures: Perceptual Speed

FIRST AND LAST NAMES TEST

Description: Adapted from Thurstone's First Names. The subject examines 20 full names, including first and last. Later, when the last names are presented to him in a different order, he writes the appropriate first name in front of each last name. Copyright ETS.

Length of each part: 15 items, 3 minutes for memorizing, 2 minutes for testing, suitable for grades 6-16.

Measures: Associative Rote Memory

II. B. Tests, Cognitive, Perceptual, Psychomotor, and Memory dimensions

FORM BOARD TEST

Description: Each item presents 5 shaded drawings of pieces some or all of which can be put together to form a figure presented in outline form. The task is to indicate which of the pieces when fitted together would form the outline. Copyright ETS.

Length of each part: 24 items, 8 minutes, suitable for grades 9-16

Measures: Visualization

Note: also called the Minnesota Paper Form Board Test

GESTALT COMPLETION TEST

Description: A test suggested by the Street Gestalt Completion Test. Drawings are presented which are composed of black blotches representing parts of the objects being portrayed. The subject writes down the name of the objects, being as specific about them as he can. Copyright ETS.

Length of each part: 10 pictures, 3 minutes, suitable for grades 6-16

Measures: Speed of Closure

GESTALT TRANSFORMATION

Description: A test developed in Guilford's project. The task is to indicate which of five listed objects has a part that will serve a specified purpose. Copyright Sheridan Supply Co.

Length of each part: 10 items, 5 minutes, suitable for grades 10-16

Measures: Semantic Redefinition

HIDDEN FIGURES TEST

Description: An adaptation of the Gottschaldt Figures Test popularized by Thurstone. The task is to decide which of 5 geometrical figures is embedded in a complex pattern. The difficulty level of this test is high. This particular form of the test was developed in connection with a project designed to study Field-Independence (see H. A. Witkins, et. al. references). The test has some variance on Spatial Orientation. Copyright ETS.

Length of each part: 16 items, 10 minutes, suitable for grades 6-16

Measures: Flexibility of Closure

HIDDEN PATTERNS TEST

Description: A test suggested by Thurstone's Designs. Each item consists of a given geometrical pattern in some of which a single given configuration is embedded. The task is to mark each pattern in which the configuration occurs. These are easy items given under speeded conditions. Copyright ETS.

Length of each part: 200 patterns, 2 minutes, suitable for grades 6-16

Measures: Flexibility of Closure

IDENTICAL PICTURES TEST

Description: Adapted from tests originally by Thurstone. For each item the subject is to check which of 5 numbered geometrical figures or pictures in a row is identical to the given figure at the left end of the row. Copyright ETS.

Length of each part: 48 rows, 1½ minutes, suitable for grades 6-16

Measures: Perceptual Speed

INFERENCE TEST

Description: A test adapted with permission from a similarly named test in Guilford's project. The task is to select the one of 5 conclusions that can be drawn from each given statement. Copyright ETS.

Length of each part: 10 items, 6 minutes, suitable for grades 11-16

Measures: Syllogistic Reasoning

LETTER SETS TESTS

Description: Suggested by Thurstone's Letter Grouping. Five sets of four letters each are presented. The task is to find the rule which relates four of the sets to each other and to mark the one which does not fit the rule. Copyright ETS.

Length of each part: 15 items, 7 minutes, suitable for grades 8-16

Measures: Induction

II. B. Tests, Cognitive, Perceptual, Psychomotor, and Memory dimensions

LETTER SPAN - AUDITORY

Description: Test developed by Kelley. This test is similar in manner of presentation and in length to Auditory Number Span Test, except that letters are used instead of digits.

Note: The test items to be read by the examiner are contained in the Key to this test at the end of this manual. Copyright ETS.

Length: 24 series, about 10 minutes, suitable for grades 6-16

Measures: Memory Span

Note: This test also called the Letter Span Test II (Auditory)

LOCATIONS TESTS

Description: Adapted from Thurstone's Marks. For each item, five rows of places and gaps are given. In each of the first four rows one place in each row is marked according to a rule. The task is to discover the rule and to mark one of 5 numbered places in the fifth row accordingly. Copyright ETS.

Length of each part: 14 items, 6 minutes, suitable for grades 8-16

Measures: Induction

LOGICAL REASONING

Description: A test developed in Guilford's project. This test consists of formal syllogisms for which the task is to choose the correct conslusions that can be drawn from two given statements. 4-choice items. Copyright Sheridan Supply Co.

Length of each part: 20 items, 10 minutes, suitable for grades 11-16

Measures: Syllogistic Reasoning

MAP PLANNING TEST

Description: Adapted from AAF Printed Classification Test. The examinee sees diagramatic sections representing city maps. The streets are blocked at various points by barriers represented by circles. The examinee must plan routes between given points in such a way that no roadblocks need to be crossed. The task is to find the shortest available route as quickly as possible. Copyright ETS.

Length of each part: 2 maps each with 10 routes, 3 minutes, suitable for grades 6-16

Measures: Spatial Scanning

MATCH PROBLEMS II

Description: A test developed in Guilford's project. The task is to indicate up to four different sets of a specified number of lines, representing matches, which may be taken away from a pattern of such lines in order to leave a certain number of squares or triangles. Copyright Sheridan Supply Co.

Length of each part: 5 items, each with 4 sets, 7 minutes, suitable for grades 11-16

Measures: Flexibility

MATCH PROBLEMS V

Description: A test developed in Guilford's project. The task is to indicate several different patterns of matches that can be removed to leave a specified number of squares. Many set-breaking solutions are needed. Copyright Sheridan Supply Co.

Length of each part: 3 items, each with 6-8 scorable units, 5 minutes Suitable for grades 11-16

Measures: Flexibility

MATHEMATICS APTITUDE TEST, R-1

Description: This consists of 5-choice word problems requiring arithmetic only. It is intended for younger subjects than is Mathematics Aptitude Test R-2, but there is a good deal of overlap in the item difficulties. Adding other suitable arithmetic reasoning tests to the battery would be desirable. Copyright ETS.

Length of each part: 15 items, 10 minutes, suitable for grades 6-12

Measures: General Reasoning

II. B. Tests, Cognitive, Perceptual, Psychomotor, and Memory dimensions

MATHEMATICS APTITUDE TEST R-2

Description: This consists of 5-choice word problems requiring arithmetic or very simple algebraic concepts only. It is intended for older students than is Mathematics Aptitude Test, R-1, but overlaps R-1 in difficulty. Copyright ETS.

Length of each part: 15 items, 10 minutes, suitable for grades 11-16

Measures: General Reasoning

MAZE TRACING SPEED TEST

Description: The task is to find and mark an open path through a moderately complex series of paper mazes. Copyright ETS.

Length of each part: 4 scorable units, 3 minutes, suitable for grades 6-16

Measures: Spatial Scanning

MECHANICAL INFORMATION

Description: This is a factual information test in practical, work-shop mechanics. Each item has 4 response choices usually consisting of the name of a tool or a part of some machine. Copyright ETS.

Length of each part 15 items, 5 minutes, suitable for grades 8-16

Measures: Mechanical Knowledge

NEARER POINT TEST

Description: Adapted from AAF Printed Classification Tests. Each item consists of 2 dots, a reference point, and some distracting lines and figures. The task is to select the dot that is nearer to the reference point. Copyright ETS.

Length of each part: 30 items, 2 minutes, suitable for grades 6-16

Measures: Length Estimation

NECESSARY ARITHMETIC OPERATIONS

Description: A test adapted with permission from a similarly named test in Guilford's project. The task is to determine what numerical operations are required to solve arithmetic problems without actually having to carry out the computations. 4-choice items. Copyright ETS.

Length of each part: 15 items, 5 minutes, suitable for grades 6-16

Measures: General Reasoning

NONSENSE SYLLOGISMS TEST

Description: Suggested by Thurstone's False Premises. The subjects are presented with formal syllogisms having nonsense words so that they cannot be solved by reference to past learning. Some of the stated conclusions follow correctly from the premises and some do not. The task is to indicate which conclusions are logically correct. Copyright ETS.

Length of each part: 15 items, 4 minutes, suitable for grades 11-16

Measures: Syllogistic Reasoning

NUMBER COMPARISON TEST

Description: Adapted from the Minnesota Vocational Test for Clerical Workers. The subject inspects pairs of multi-digit numbers and indicates whether the two numbers in each pair are the same or different. Copyright ETS.

Length of each part: 48 items, $1\frac{1}{2}$ minutes, suitable for grades 6-16

Measures: Perceptual Speed

OBJECT NAMING

Description: A test developed in Guilford's project. The task is to name as many objects as possible that belong to a certain class. The score is the number of types of objects named. Copyright J. P. Guilford.

Length of each part: one class, 2 minutes, suitable for grades 6-16

Measures: Semantic Spontaneous Flexibility

OBJECT-NUMBER TEST

Description: Adapted from Thurstone's Word-Number. The subject examines 20 word-number pairs. Later, when the words are presented to him in a different order, he writes the appropriate number beside each word. Copyright ETS.

Length of each part: 15 items, 3 minutes for memorizing, 2 minutes for testing, suitable for grades 6-16

Measures: Associative Rote Memory

OBJECT SYNTHESIS

Description: A test developed in Guilford's project. The task is to name an object that could be made by combining two specified objects. Copyright J. P. Guilford.

Length of each part: 12 items, 10 minutes, suitable for grades 10-16

Measures: Semantic Redefinition

PAPER FOLDING TEST

Description: Suggested by Thurstone's Punched Holes. For each item successive drawings illustrate two or three folds made in a square sheet of paper. A drawing of the folded paper shows where a hole is punched in it. The subject selects one of 5 drawings to show how the sheet would appear when fully opened. Copyright ETS.

Length of each part: 10 items, 3 minutes, suitable for grades 9-16

Measures: Visualization

PICTURE GESTALT

Description: A test developed in Guilford's project. The task is to indicate which object in a photograph will serve a specified purpose. Copyright J. P. Guilford.

Length: 3 parts of 8 items each; total time 9 minutes, suitable for grades 10-16

Measures: Semantic Redefinition

PICTURE-NUMBER TEST

Description: Adapted from a test by Anne Anastasi. The subject examines pictures of common objects, each paired with a 2-digit number. Later, when the pictures are presented to him in a different order, he writes the appropriate number under each. Copyright ETS.

Length of each part: 21 items, 4 minutes for memorizing, 3 minutes for testing, suitable for grades 6-16

Measures: Associative Rote Memory

PLANNING AIR MANEUVERS

Description: Adapted from a test originally used in the AAF Psychology Program. Following certain rules, the examinee is required to select the most direct path in "skywriting" pairs of capital letters. Copyright J. P. Guilford.

Length of each part: 36 items, 8 minutes with spacing, suitable for grades 11-16

Measures: Figural Adaptive Flexibility

PLOT TITLES (clever)

Description: The task is to write titles for story plots. The score is the number of clever titles written. Copyright Sheridan Supply Co.

Length of each part: one story plot, 3 minutes, suitable for grades 10-16

Measures: Originality

SEEING DEFICIENCIES

Description: A test developed in Guilford's project. The subject is asked to point out the way in which a described plan or activity is faulty. Copyright J. P. Guilford.

Length of each part: 10 items, 10 minutes, suitable for grades 8-16

Measures: Sensitivity to Problems

SEEING PROBLEMS

Description: A test developed in Guilford's project. The subject is asked to list problems that might arise in connection with common objects. Copyright Sheridan Supply Co. (pre-publication).

Length: 4 parts each naming 3 objects; total time 12 minutes

Measures: Sensitivity to Problems

II. B. Tests, Cognitive, Perceptual, Psychomotor, and Memory dimensions

SHIP DESTINATION TEST

Description: A test was developed by Christensen and Guilford. The task is to use knowledge of the position of a ship with respect to a port, wind direction, ocean current, and direction of heading to compute effective distance to port following given rules. Copyright Sheridan Supply Co.

Length: 48 items, 15 minutes, suitable for grades 11-16

Measures: General Reasoning

SHORTEST ROAD TEST

Description: Adapted from AAF Printed Classification Tests. Each item consists of 2 points. Three curved or angular lines are drawn between these 2 points. The task of the examinee is to select the shortest of these lines. Copyright ETS.

Length of each part: 28 items, 2 minutes, suitable for grades 6-16

Measures: Length Estimation

SIMILE INTERPRETATIONS

Description: A test developed in Guilford's project. Incomplete sentences of the form "A woman's beauty is like the autumn because..." are presented. The task is to complete the sentences in as many ways as possible by giving different explanations for the simile. Copyright J. P. Guilford.

Length of each part: 2 sentences, 2 minutes, suitable for grades 8-16

Measures: Expressional Fluency

SPATIAL ORIENTATION

Description: This is Part V of the Guilford-Zimmerman Aptitude Survey. Each item presents two pictures of water and land scenery as seen looking out over the prow of a motor boat which has moved slightly between pictures. The task is to select the one of five dot and dash pairings in which the dot represents the old position of the prow and the dash the new position. Changes include any combination of tilt and of vertical and horizontal movement. Speed conditions are used. Copyright Sheridan Supply Co.

Length: 60 items, 10 minutes, suitable for grades 10-16

Measures: Spatial Orientation

SUBTRACTION AND MULTIPLICATION TEST

Description: Adapted from numerous tests of this factor. This is a speed test alternating 10 items of subtracting 2-digit numbers from 2-digit numbers and 10 items of multiplying 2-digit numbers by single-digit numbers. Separate tests of subtraction and multiplication would work equally well. Copyright ETS.

Length of each part: 60 items, 2 minutes, suitable for grades 6-16

Measures: Number Facility

SURFACE DEVELOPMENT TEST

Description: Adapted from Thurstone's Surface Development. In this test, drawings are presented of solid forms that could be made with paper or sheet metal. With each drawing there is a diagram showing how a piece of paper might be cut and folded so as to make the solid form. Dotted lines show where the paper is folded. One part of the diagram is marked to correspond to a marked surface in the drawing. The subject is to indicate which lettered edges in the drawing correspond to numbered edges or dotted lines in the diagram. Copyright ETS.

Length of each part: 5 items in each of 6 drawings, 6 minutes, suitable for grades 9-16

Measures: Visualization

SYMBOL PRODUCTION

Description: The task is to produce symbols to represent given activities and objects. Copyright J. P. Guilford.

Length of each part: 31 or 30 items, 5 minutes, suitable for grades 10-16

Measures: Originality

THEME TEST

Description: Adapted from Taylor's version of a test by Cattell. The task is to write as much as possible about a given topic. The score is the number of words written. Copyright ETS.

II. B. Tests, Cognitive, Perceptual, Psychomotor, and Memory dimensions

Length of each part: one theme, 4 minutes, suitable for grades 8-16

Measures: Ideational Fluency

THING CATEGORIES TEST

Description: Adapted from Taylor's Things Round, a version of a test by Cattell. The subject is asked to list the names of things that are alike in a specified way. The score is the number of names of things listed. Copyright ETS.

Length of each part: one category, 3 minutes, suitable for grades 8-16

Measures: Ideational Fluency

TOPICS TEST

Description: Adapted from Taylor's version of a test by R. B. Cattell. The task is to write as many ideas as possible about a given topic. The score is the number of separate ideas (phrases or sentences) written. Copyright ETS.

Length of each part: one topic, 4 minutes, suitable for grades 8-16

Measures: Ideational Fluency (22)

TOOL KNOWLEDGE TEST

Description: This test is patterned after Navy mechanical tests. Each item presents the picture of an object used in some mechanical operation along with the pictures of 3 tools or other objects. The task is to select the one of the 3 tools which is commonly used with the first object. Copyright ETS.

Length of each part: 15 items, 5 minutes, suitable for grades 6-16

Measures: Mechanical Knowledge

UTILITY TEST

Description: A test developed in Guilford's project. The score in this test is the number of times the class of uses is changed as the subject lists different uses for a given object. Copyright Sheridan Supply Co.

Length of each part: one object, 5 minutes

II. B. Tests, Cognitive, Perceptual, Psychomotor, and Memory dimensions

Measures: Semantic Spontaneous Flexibility

VOCABULARY V-1

Description: Adapted from a test by J. B. Carroll. This is a 4-choice synonym test. Copyright ETS.

Length of each part: 18 items, 4 minutes, suitable for grades 7-12

Measures: Verbal Comprehension

VOCABULARY, V-2

Description: Adapted from a Cooperative Vocabulary Test. This is a 5-choice synonym test. The format is intentionally left different from that of V-1 to reduce common variance of an artifactural nature. Copyright ETS.

Length of each part: 18 items, 4 minutes, suitable for grades 7-12

Measures: Verbal Comprehension

WIDE RANGE VOCABULARY TEST

Description: Adapted from a Cooperative Vocabulary Test. This is a 5-choice synonym test having items ranging from very easy to very difficult. Copyright ETS.

Length of each part: 24 items, 6 minutes, suitable for grades 7-16

Measures: Verbal Comprehension

WORD ARRANGMENTS

Description: A test developed in Guilford's project. The task is to write as many sentences as possible containing a set of 4 specified words. Copyright J. P. Guilford.

Length of each part: one set of 4 words, 4 minutes, suitable for grades 8-16

Measures: Expressional Fluency

II. B. Tests, Cognitive, Perceptual, Psychomotor, and Memory dimensions

WORD BEGINNINGS AND ENDINGS TEST

Description: Similar to Thurstone's First and Last Letters. The task is to write as many words as possible beginning with one given letter and ending with another. The score is the number of words written. Copyright ETS.

Length of each part: one pair of letters, 3 minutes, suitable for grades 6-16

Measures: Word Fluency

WORD BEGINNINGS TEST

Description: Similar to Thurstone's Prefixes. The task is to write as many words as possible beginning with certain given letters. The score is the number of words written. Copyright ETS.

Length of each part: one set of letters, 3 minutes, suitable for grades 6-16

Measures: Word Fluency

WORD ENDINGS TEST

Description: Similar to Thurstone's Suffixes. The task is to write as many words as possible ending with certain given letters. The score is the number of words written. Copyright ETS.

Length of each part: one set of letters, 3 minutes, suitable for grades 6-16

Measures: Word Fluency

II. B. Tests, Cognitive, Perceptual, Psychomotor, and Memory dimensions

169. Guilford, J. P. (Ed). Printed Classification Tests. AAF Aviation Psychology Program Research Report No. 5, 1947. Washington, DC: U. S. Government Printing Office.

This document is the primary reference source for many of the printed tests used in psychomotor and spatial factor analytic studies. Unfortunately, however, it is no longer available from the U.S. Government Printing Office.

PRACTICAL JUDGMENT

Description: Consists of problems or predicaments of a common everyday type. Multiple-choice answers offered different more-or-less plausible solutions, of which the subject must select the best alternative.

Measures: This is a marker test for Practical Judgment.

COMBAT PLANES

Description: In this test two squadrons of planes in mock combat are presented. The planes vary in type. The task is to determine as quickly as possible, from rules given in the directions, which opponents each plane could attack.

Measures: Factor analytic study. Factor loading on AAF Integration I: .57

FLIGHT FORMATION

Description: The positions of three planes in flight plus certain moves from the given positions are described. The examinee has then to select the correct drawing of their final formation.

Measures: Factor analytic study. Factor loading on AAF Integration I: .46

SIGNAL INTERPRETATION

Description: In each problem there are pictured ten airplane carriers. The examinee is to determine, according to the direc-

tions, from which of these carriers planes are about to take off.

Measures: Factor analytic study. Factor loading on AAF Integration I: .59

170. Guilford, J. P. The nature of creativity. In R. W. Russells, (Ed), Frontiers in psychology. Chicago: Scott & Foresman, 1964.

GUILFORD'S BATTERY FOR CREATIVE THINKING

Source: Sheridan Supply Co., Beverly Hills, California.

Data: test-retest reliability ranges from .50 to .92 (mean = .75)

Descriptions:
FLUENCY MEASURES:
Word Fluency: The task is to write as many words as possible, containing a given letter of the alphabet (8 min.)

Expressional Fluency: Four-word sentences have to be constructed, each word beginning with a given letter (8 min.)

Associational Fluency: A list of words that are similar in meaning to a given (e.g., hard) has to be produced (4 min.)

Ideational Fluency: Subject has to name things that belong in a certain class (e.g., name fluids that will burn) (12 min.)

FLEXIBILITY MEASURES:

Alternate Uses: Various uses for a common object (e.g., a newspaper) have to be listed (10 min.)

Consequences: The task is to think of a large number of ideas in connection with a new and unusual situation (e. g., What would be the result if people no longer needed or wanted to sleep?) (20 min.)

Match Problems: In this test, drawings of headless matches are laid out in patterns. The task is to remove some of the matches so that the remaining ones form new patterns (14 min.).
ELABORATION MEASURES- evaluates the ability to elaborate upon given information in a variety of ways.
Making Objects: Some given figures have to be combined to form a specified object. The emphasis is on the use of the same elements in different ways and in different combinations (6 min.).
Decorations: The task is to decorate the outline drawings of various objects (12 min.)
Possible Jobs: The subject is required to think of as many possible jobs as he can which might be indicated by a certain emblem or figure (e.g., a light bulb).

Times given above do not include the time need to give instructions.

171. Harris, William. The Object Identification Test: a stress-sensitive perceptual test. 209-1, NONR 3135, Human Factors Research, Inc., Goleta, Calif., Feb. 67. (AD 648 999)

OIT, OBJECT IDENTIFICATION TEST

Cost: group, 18 min. for 8-item test. 7 slides of drawings needed per item. Equipment for slide projection needed.

Data: Norms and standard deviations for each of 28 test items given based on two groups of college students, N=54 and N=163. Two groups of 40 subjects each were compared for test performance under non-noise condition and 103 db. condition. The curve difference was significant at $p < .01$

Description: Test content, administration and construction details given in article. Eight items, each consisting of an ordered series of 7 line drawings such that the first drawing is very ambiguous and ambiguity is lessened with each successive drawing by addition to details. Subject responds to each drawing of an item; score is the number of the drawing correctly identified and for which the subsequent drawings were identified correctly. 28 items, individual discriminative, are available with relative difficulty implied by the norms.

Measures: Perceptual performance. Supposed to be sensitive to environmental stress effects such as intense noise, electric shock, and extended close confinement.

172. Hauty, G. R. and Payne, R. B. Mitigation of work decrement. Journal of Experimental Psychology, 1955, 49, 60-67.

MULTIDIMENSIONAL PURSUIT TEST, USAF SAM

Subjects: 168 male AF basic trainees

Tests used: USAF SAM Multidimensional Pursuit Test* and USAF SAM Self-pacing Discrimination Reaction Time Test.

Method: 7x3x2 matrix, 4 subjects per cell. Effects tested were: drugs (7 types), correct response stimulus (observation of instrument position, supplementary visual or auditory signal), and knowledge of task duration (4 vs 7 hours). The Multidimensional Pursuit Test was performed for 7 hours, while the reaction time test was performed immediately afterward for 16 minutes.

Results: The Multidimensional Pursuit Test effectively discriminated between all conditions. The Discrimination Reaction Time Test did not show any transfer of impairment effect.

*This test is described in Melton's Apparatus Tests, Restricted Supplement, but copies of this report are no longer available.

173. Herbert, M. J. Analysis of a complex skill: vehicle driving. Human Factors, 1963, 5, 363-372.

DRIVING PERFORMANCE BATTERY

Subjects: 180 male Air Force and Army volunteers. Mean age was 22 years. 36 subjects per experimental condition.

Method: 12 driving tests with one to three performance measures each were administered prior to and after a criterion measure. Subject driving experience was balanced across the criterion conditions. The criterion measure consisted of the number of hours (0, 1, 3, 7, or 9) spent driving a truck on a desert track. The use of the

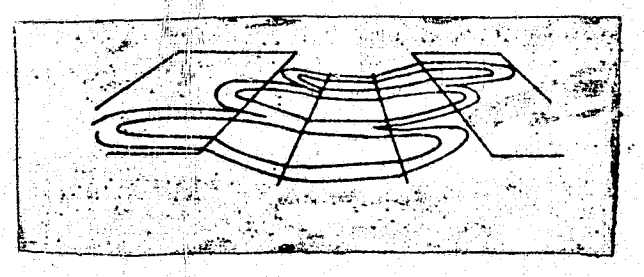
criterion measure was based on the assumption that the greater the time spent driving, the greater the degrading effect on the abilities being utilized; i.e., if the driving tests were valid tests of driving abilities than only the retest performances should correlate with the criterion, not the initial test performances.

Results: None of the initial performance measures on the driving tests correlated significantly with the criterion, while several of the final driving test performances did correlate significantly. Eight of the final driving test performance measures were chosen for the factor analysis on the basis of their correlation with the criterion and their reliabilities (36 subjects serving under the 0 hour condition yielded one hour test-retest reliabilities). Correlations ranged from .18 to .38 ($\bar{x}$ = .24). Reliabilities ranged from .35 to .82 ($\bar{x}$ = .65).

The factor analysis yielded the following factors: multilimb coordination, spatial orientation, proprioception, response orientation, and reaction time. DRIVING PERFORMANCE CRITERION loaded on two of the factors as follows: Multilimb Coordination .36
Spatial Orientation .37

CONTOUR of the DRIVING PERFORMANCE BATTERY

Data: One hour test-retest reliability: .82
Correlation with hours spent driving: .24



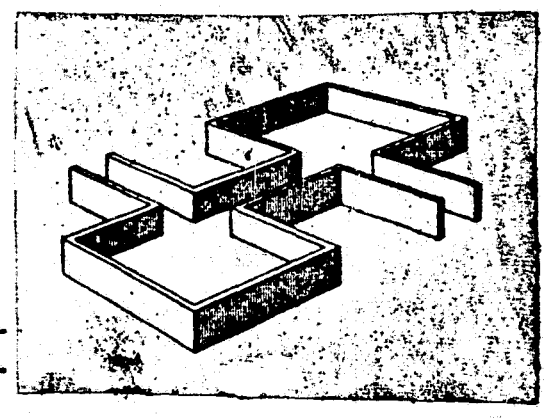
Description: A specially contoured trough 180 ft. long and 32 ft. wide was constructed. In cross section, the middle portion was 3 ft. below ground level. Three circular, inter-locking paths were positioned diagonally upon the trough. The path width was 7 ft. except at the point of contact between adjacent circles, where it was expanded to 10 ft. The diameter of each circle to the center point of the path was $27\frac{1}{2}$ ft. After the driver's door window had been blacked-out, he was told to drive through the interlocking circles in a clockwise direction and come to a stop at his starting point. He was to keep both front wheels from touching the boundary lines of the path. Performance measure: total time required.

Measures: factor loadings found:
Multilimb coordination: .31
Spatial orientation: .26
Proprioception: .26

II. B. Tests, Cognitive, Perceptual, Psychomotor, and Memory dimensions

MAZE of the DRIVING PERFORMANCE BATTERY

Data: One hour test-retest reliability: .58
Correlation with hours spent driving: .38



Description: The maze consisted of two 25 ft. square "jockeying" boxes connected at diagonal corners by an alley 8 ft. wide and 20 ft in length. Alleys of the same dimensions placed at right angles to the connecting alley served as entrances to the boxes. The subject was instructed to back through the entire maze. Forward motion was restricted to activity in the boxes. Performance measure: number of direction changes.

Measures: factor loadings found:
Spatial orientation .51
Response orientation .63

MIRROR REVERSE of the DRIVING PERFORMANCE BATTERY

Data: One hour test-retest reliability: .82
Correlation with hours spent driving: .18

Description: A tape-outlined straight path $6\frac{1}{2}$ ft x 167 ft was used. The truck was positioned between the boundary lines at one end of the path, the windshield was covered, and the subject was instructed to back to the other end of the path using the side-mirror for guidance. He was told that the four truck wheels would touch the lines but could not go beyond their limits. Performance measure: distance-in-error

Measures: factor loadings found: Response orientation: .64

NON-VISUAL of the DRIVING PERFORMANCE BATTERY

Data: One hour test-retest reliability: .52
Correlation with hours spent driving: .27

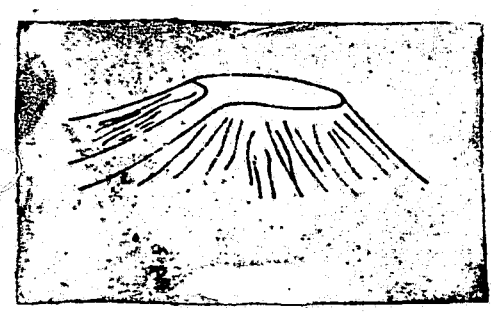
Description: A straight, crushed-rock path 12 in. x 167 ft. was set flush into the desert hard-pan. The two left wheels of the truck were positioned on the rock path at one end. The driver wore blackout goggles and was instructed to drive forward to the far end without leaving the rock path. Score: distance-in-error.

Measures: factor loadings found:
Spatial orientation: .46
Proprioception: .52

II. B. Tests, Cognitive, Perceptual, Psychomotor, and Memory dimensions

NO-SLIP BACK of the DRIVING PERFORMANCE BATTERY

Data: One hour test-retest reliability: .35
Correlation with hours spent driving: .22



Description: A path 10 ft x 40 ft set at a 15° incline. Drive forward half the distance up the slope. Come to a stop, then proceed to the top without any backward slip. Neither the hand-brake nor the hand-throttle could be used. The only acceptable response was to lift the feet quickly from clutch and brake pedals, then depress the accelerator with the right foot. Score: distance-in-error.

Measures: factor loadings found:

Proprioception	.39
Response orientation	.26
Reaction time	.56

NO-SLIP FORWARD of the DRIVING PERFORMANCE BATTERY

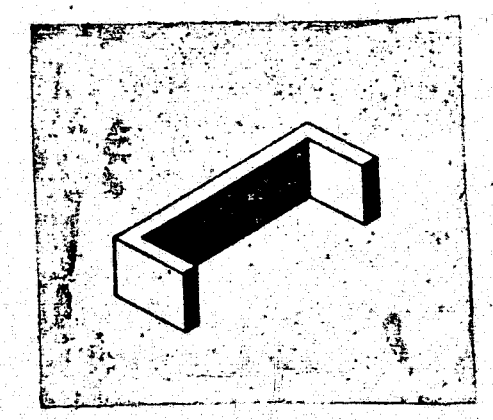
Data: one hour test-retest reliability: .76
correlation with hours spent driving: .20

Description: The test situation is the same as that for No-Slip Back except that the vehicle was headed down slope and was to be returned to the top of the hill. Performance score: distance-in-error.

Measures: factor loadings found:
Multilimb coordination: .31
Reaction Time: .47

PARALLEL-PARK LEFT of the DRIVING PERFORMANCE BATTERY

Data: One hour test-retest reliability: .67
Correlation with hours spent driving: .25

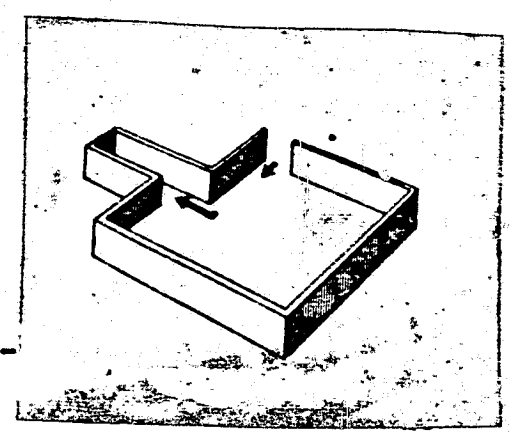


Description: The stall was 3 ft. x $7\frac{1}{2}$ ft x 23 ft. The driver was instructed to pull forward, come to a stop at an appropriate place, then back into the stall located on his left. Score: number of direction changes.

Measures: factor loadings found:
Spatial orientation: .62

TRAILER-BACK of the DRIVING PERFORMANCE BATTERY

Data: One hour test-retest reliability: .69
Correlation with hours spent driving: .18



Description: The subject was required to back a 500 gallon water trailer into a stall measuring 8 ft x 15 ft. The task was complicated by positioning the truck and trailer 30 ft. in front and 30 ft. to the left and at a 90° angle to the stall opening. Maneuvering was further restricted to a 60 ft. square space immediately in front of the stall. Performance measure: total time required.

Measures: factor loadings found: spatial orientation: .46

174. Hines, M. and O'Connor , J. A measure of finger dexterity. Personnel Journal, 1926, 4, 379-382.

O'CONNOR FINGER DEXTERITY

Description: Specifications for test construction and administration (Note: Fleishman uses a different method) and norms based on 1021 women and 158 men are given

Data: reliability: Test-retest for 56 persons was .60.

Validity: 77 women hired for fine meter work:

Quartile	% successful
1st	88%
2nd	89%
3rd	50%
4th	40%

175. Hoepfner, R., Guilford, J. P. and Merrifield, P. R. Studies of aptitudes of high-level personnel: A factor analysis of the symbolic-evaluation abilities. Report No. 33, Psychological Laboratory, University of Southern California, Los Angeles, Calif., Dec 1964. (AD 46459)

II. B. Tests, Cognitive, Perceptual, Psychomotor, and Memory dimensions

SYMBOL MANIPULATION TEST AND RELATED WORDS I TEST

Subjects: 86 boys, 139 girls; high school seniors.

Method: 53 test measures were used in an 8-hour battery. 25 of the tests were designed to measure six experimental factors: evaluation of symbolic: units, classes, relations, systems, transformations and implications. The remaining tests were adapted marker tests for reference factors, ratings designed to reflect motivational level, and published tests from school records.

Results: The six hypothesized factors and the twelve reference factors emerged. A general motivation factor did not result, a doublet and a singlet occuring instead. The Symbol Manipulation test was found to have loadings on two of the hypothesized factors.

	Eval. of symbolic classes	Eval. of sym. relations	Reliability-Spearman-Brown Correlation of parts
Symbol Manipulation Test	.33	.58	.74
Related Words I Test	.28	.45	.55

Test Descriptions: (ESR02C)

Symbol Manipulation Test: Subject must decide whether a given relationship between two letters follows logically from other statements of relationship involving the same letters, where the relationships are "greater than", "equal to", and "less than". All statements are in symbolic form. Two parts; 15 items per part; 8 minutes working time.

Related Words I Test (ESR03A): Subject must estimate which of three alternative word pairs is most similar to a given related pair. The relation between members of any pair is based upon the order and position of letters and the vowels and consonants that are changed or moved. Three parts; 10 items per part; 12 minutes working time.

176. Hoepfner, Nihira, and Guilford, J. P. Intellectual Abilities of symbolic and semantic judgment. Psychological Monographs, 1966, 80, (16, Whole No. 624). (Also available from ASTIA, AD 651 222)

II. B. Tests, Cognitive, Perceptual, Psychomotor, and Memory dimensions

SEEING IMPLICATIONS AND CONSEQUENCES

Subjects: 86 boys and 139 girls; high school seniors.

Method: A factor analytic study to identify the evaluation components of the structure-of-intellect model.

Results: The expected factors of evaluation were obtained. The tests which had previously identified a factor called Sensitivity to Problems were found to load significantly, instead, on seeing implications and Consequenses or Guilford's Cognition of semantic implications (CMI). The tests which loaded both significantly and only on CMI are as follows:

Tests	Factor loadings
Pertinent Questions - Part I	.75
Pertinent Questions - Part II	.68
Seeing Problems	.43
Apparatus Test	.34

177. Horvath, E. Psychological stress: A review of definitions and experimental research. General Systems Yearbook, 1959, 4, 203-230.

TEST PERFORMANCE AND STRESS

This is a review of stress experimentation conducted in years prior to 1959. Summary comments are given below for the effects of various stressors on particular tests. The primary references are given by letter and are listed below.

ARITHMETIC PROBLEM SOLVING

Long Division problems: reports of failure lowered performance while complaints about the subject's conduct did not. (ref. j). Anxiety, as measured by the TMAS, had no differential effect on performance under neutral, failure, or anxiety-arousing conditions (ref. j).

Subtraction problems: Random noise interferes with performance (ref. f).

Addition problems: Random noise of a lower intensity than Broadbent's caused only an initial decrement on rapid, simple problems (ref. a). 30 hours without sleep caused no performance decrement (ref. r). Short duration, mild anoxic conditions caused only a initial decrement on the solution of simple problems, followed by rapid recovery and continued improvement (ref. m).

II. B. Tests, Cognitive, Perceptual, Psychomotor, and Memory dimensions

Addition & Subtraction problems: Fatigue from continued performance on a variety of mental tasks led to an increase in the length and the frequency of blocking of responses in the solutions of addition and subtraction problems (ref. d).

CHOICE REACTION TIME

Noise effect on visual stimulus test, 25 minutes long: to be effective random noise must be at least 100 dbls and above 2000 cps (ref. e).
Sleep loss: Loss of up to 90 hours had no effect on a brief task but a 10-minute test was effected (ref. o). Loss of one nights sleep effected performance on visual stimulus test if preceded by a 30-minute tracking task. Effect was omission of responses (ref. l).
Temperature: effect was increase in errors (ref. l).

MIRROR TRACING

Anxiety from misinformation regarding maladjustment: increase in time needed (ref. c). No increase in time (ref. q).
Anxiety test scores: no correlation with performance (ref. b).

PURSUIT METER TASK (PURSUIT TRACKING)

Temperature: temperatures below and above normal decreased performance over a 5-day period (ref. m). High temperatures decreased accuracy of response (ref. l).
Sleep loss: reduced activity level, i.e., increased failure to correct errors (ref. l).

SIMPLE REACTION TIME VISUAL AND AUDITORY

Temperatures between 50°F and 117°F: review concludes that reaction time is not affected (ref. g).
Anoxia, short duration: no effect (ref. p).

TAPPING TEST SPEED

8 cps beat: internal caused a performance drop, but neither external nor signal had any effect (ref. i).
Sleep loss: 90 hours deprivation had no effect (ref. k).
Anoxia: a significant decrement (ref. h). Only a decrement tendency (ref. p).

VIGILANCE TASK

30 hour sleep deprivation caused a performance decrement on a vigilance task (ref. r).

II. B. Tests, Cognitive, Perceptual, Psychomotor, and Memory dimensions

a. Angelino, H. and Mech, E. V. Factors influencing routine performance under noise: II. An exploratory analysis of the influence of "adjustment." Journal of Psychology, 1955, 40, 397-401.

b. Ausubel, D. P., Schiff, H. M. and Goldman, M. Qualitative characteristics in the learning process assoicated with anxiety. Journal of Abnormal Social Psychology, 1953, 48, (4), 537-547.

c. Brier, E. G. The effect of induced anxiety on flexibility of intellectual functioning. Psychological Monographs, 1951, 65, No. 326.

d. Bills, A. G. Blocking: a new principle of mental fatigue. American Journal of Psychology, 1931, 43, 230-245.

e. Broadbent, D. E. Effects of noises of high and low frequency on behavior. Ergonomics, 1957, 1, 21-29.

f. Broadbent, D. E. Effect of noise on an intellectual task. Journal of the Accoustical Society of America, 1958, 30, 824-826.

g. Forlano, G., Bermack, J. E. and Conkley, J. D. The effect of ambient and body temperatures upon reaction time. Special Devices Center Report, No. 151-1-13, 1948.

h. Malmo, R. B. and Finan, J. L. A comparative study of eight tests in the decompression chamber. American Journal of Psychology, 1944, 57, 389-405.

II. B. Tests, Cognitive, Perceptual, Psychomotor, and Memory dimensions

i. McKenzie, R. E. The effect of biaural beats on performance. Unpublished doctoral dissertation, University of Michigan, 1957.

j. Osler, Sonia F. Intellectual performance as a function of two types of psychological stress. Journal of Experimental Psychology, 1954, 47, 115-121.

k. Patrick, G. T. W. and Gilbert, J. A. On the effects of loss of sleep. Psychology Review, 1896, 3, 469-483.

l. Pepler, R. D. Warmth and lack of sleep: accuracy or activity reduced. APU 286, Human Performance Report, No. 4, MRC Appl. Psychological Research Unit, Cambridge, England, 1958.

m. Russell, R. W. The effects of mild anoxia on simple psychomotor and mental skills. Journal of Experimental Psychology, 1948, 38, 178-187.

n. Teichner, W. H. and Kobrick, J. L. Effects of prolonged exposure to low temperature on visual-motor performance. Journal of Experimental Psychology, 1955, 49, (2), 122-126.

o. Tyler, D. B. The effect of amphetamine sulfate and some barbiturates on the fatigue produced by prolonged wakefulness. American Journal of Physiology, 1947, 150, 253-262.

p. Waldfogel, S., Finesinger, J. E. and Verzeano, M. The effect of low oxygen on psychologic performance tests in psychoneurotic patients and normal controls. Psychosomatic Medicine, 1950, 12, 244-249.

II. B. Tests, Cognitive, Perceptual, Psychomotor, and Memory dimensions

q. Wiener, M. The effects of two experimental counseling techniques on performances impaired by induced stress. Journal of Abnormal and Social Psychology, 1955, 51, 565 572.

r. Wilkinson, R. T. Effects of sleep loss on performance. APU 323, Human Performance Report No. 4, MRC Applied Psychological Research Unit, Cambridge, England, 1958.

II. B. Tests, Cognitive, Perceptual, Psychomotor, and Memory dimensions

178. Kelley, H. P. Memory abilities: a factor analysis. Psychometric Monographs, No. 11, 1964.

MEMORY FACTORS

Summary: 40 tests including 13 AF Classification reference tests and 27 memory tests were administered to 442 pilot cadets (77% with some college work) to investigate relatively immediate intentional memory. Four factors were hypothesized, of which the first three were clearly identified by the analysis.

1. Rote memory: ability to recall learned, meaningless material.
2. Meaningful memory: ability to recall learned, meaningful material.
3. Span memory: ability to recall perfectly a series of unrelated items after only one presentation of the series.
4. Visual memory: ability to recall material learned by the formation of an image of a whole visual field.

Other conclusions drawn were: (1) factors 1 thru 3 are general for both visual and auditory presentation; (2) both Rote Memory and Meaningful Memory are general for recognition, completion recall, and free recall tests while Span Memory is possibly restricted to free-recall tests; (3) Meaningful Memory is probably general for both verbal and nonverbal materials, while Rote and Span Memories are possibly restricted to verbal material; (4) evidence with respect to Visual Memory is equivocal; (5) analysis suggests the possibility of an Auditory Memory factor.

Further descriptions and sources for the memory tests are given in the article.

The use of a (?) in the factor descriptors indicates that identification was not clear for that factor.

ARITHMETIC REASONING, Test I

Description: The examinee must solve mathematical problems which are stated verbally; many of the problems are presented in aviation terminology.

Measures: Factor loadings:
.25 on verbal comprehension
.54 on numerical facility
.28 on visualization (?)
.36 on kinesthetics-spatial-reasoning (?)
.28 on visual memory (?)

II. B. Tests, Cognitive, Perceptual, Psychomotor, and Memory dimensions

LETTER SPAN TEST I (VISUAL)

Description: After seeing a sequence of letters, the examinee must reproduce the sequence. The sequences range in length from three to eleven letters. Each sequence is presented one letter at a time by flash cards on a display stand.

Measures: factor loadings: .66 on span memory

LETTER SPAN TEST II (AUDITORY)

Description: After hearing a sequence of letters, the examinee must reproduce the sequence. The sequences range in length from three to eleven letters.

Measures: factor loadings: .33 on rote memory
.64 on span memory

Note: also see Letter Span-Auditory

MAP MEMORY TEST I (REPRODUCTION)

Description: After studying a product-type map of a fictional country, the examinee must reproduce the map.

Measures: factor loadings: .35 on perceptual speed
.25 on visualization (?)

MAP MEMORY TEST II (VERBAL RECALL)

Description: After studying a map of a section of town and countryside, the examinee must answer multiple-choice questions about the area portrayed by the map.

Measures: factor loadings: .24 on visual memory (?)

MAP MEMORY TEST III (RECOGNITION)

Description: The examinee must learn the map of an area of countryside, so that when he is presented with five representations of a section of that map he can indicate which is the correct representation.

Measures: factor loadings: .21 on perceptual speed
.46 on visualization (?)

II. B. Tests, Cognitive, Perceptual, Psychomotor, and Memory dimensions

MEANINGFUL MEMORY: NUMBER

Description: The Meaningful Memory Test was divided into three sections, each section being scored separately. Hence, the sections were treated as three separate tests. In the Number section, the examinee must learn detailed information about inventories in two stores so that he can answer multiple-choice questions about them.

Measures: factor loadings: .36 on rote memory
.31 on visual memory (?)

MEANINGFUL MEMORY: PARAGRAPH

Description: In the Paragraph section of the test the examinee must learn a long encyclopedia-type article about a country so that he can answer true-false questions about it.

Measures: factor loadings: .51 on verbal comprehension
.20 on rote memory

MEANINGFUL MEMORY: PICTURE

Description: In the Picture section of this test the examinee must learn the details of a sketch representing a Venetian scene so that when he is presented with a sketch of a similar Venetian scene he can answer true-false questions about the similarities and differences of the two pictures.

Measures: factor loadings: .22 on immediate meaningful memory

MEMORY FOR IDEAS TEST

Description: After hearing a brief, one-paragraph story, "The Marble Statue," the examinee must reproduce it in his own words.

Measures: factor loadings: .33 on immediate meaningful memory
.54 on auditory memory (?)

MEMORY FOR INSTRUCTIONS TEST

Description: After hearing a set of instructions (e.g., "Check the 9. Cross out the R."), the examinee must carry out the instructions. The sets range in length from two to five instructions.

Measures: factor loadings: .41 on span memory

II. B. Tests, Cognitive, Perceptual, Psychomotor, and Memory dimensions

MEMORY FOR LIMERICKS TEST

Description: The examinee must learn a group of limericks so that when he is presented with the first four lines of a limerick he can correctly reproduce the idea and key words of the fifth line.

Measures: factor loadings: .48 on immediate meaningful memory
.32 on auditory memory (?)
.19 on verbal comprehension

MEMORY FOR NUMBERS TEST

Descriptions: The examinee must learn pairs of words and numbers so that when he is presented with the word of a pair he can reproduce the number.

Measures: factor loadings: .53 on rote memory
.21 on visual memory (?)

MEMORY FOR RELATIONS TEST

Description: The examinee must learn a group of 3x3 progressive matrices of varied content (including letters, numbers, names of months, and geometric designs) so that when he is presented with the upper left-hand cell of a matrix he can reproduce whichever of the other cells is called for. (Actually, only cells 5, 6, 8 and 9 were required as responses; cells 2, 3, 4, and 7 were not tested.)

Measures: factor loadings: .26 on numerical facility
.22 on perceptual speed
.39 on visualization (?)
.28 on visual memory (??)

MEMORY FOR SYLLABLES TEST I

Description: The examinee must learn pairs of nonsense syllables so that when he is presented with the first syllable of a pair he can reproduce the second syllable.

Measures: factor loadings: .41 on rote memory
.58 on doublet-nonsense-syllable paired assoc.

MEMORY FOR SYLLABLES TEST II.

Description: This test is a parallel form of Memory for Syllables Test I, using different nonsense syllables. The examinee must learn pairs of nonsense syllables so that when he is presented with the first syllable of a pair he can reproduce the second syllable.

Measures: factor loadings: .34 on rote memory
.35 on doublet-nonsense-syllable paired assoc.

MEMORY FOR WORDS TEST I (UNRELATED WORDS)

Description: The examinee must learn pairs of unrelated one-syllable nouns so that when he is presented with the first word of a pair he can reproduce the second word.

Measures: factor loadings: .19 on verbal comprehension
.64 on rote memory
.25 on visual memory (??)

MEMORY FOR WORDS TEST II (RELATED WORDS)

Description: The examinee must learn pairs of related nouns so that when he is presented with the first word of a pair he can reproduce the second word.

Measures: factor loadings: .36 on rote memory
.43 on immediate meaningful memory

NUMBER SPAN TEST I (AUDITORY)

Description: After hearing a sequence of digits, the examinee must reproduce the sequence. The sequences range in length from four to twelve digits.

Measures: factor loadings: .27 on rote memory
.57 on span memory
.21 on visual memory (??)

Note: also see Auditory Number Span Test

NUMBER SPAN TEST II (VISUAL)

Description: After seeing a sequence of digits, the examinee must reproduce the sequence. The sequences range in lenth from four to twelve digits. Each sequence is presented one digit at a time by flash cards on a display stand.

Measures: factor loadings: .26 on rote memory
.59 on span memory

II. B. Tests, Cognitive, Perceptual, Psychomotor, and Memory dimensions

NUMERICAL OPERATIONS

Description: The examinee must solve simple problems in addition, subtraction, multiplication, and division.

Measures: factor loadings: .67 on numerical facility
.26 on perceptual speed

READING COMPREHENSION

Description: The examinee must make valid inferences from reading material as well as answer more direct questions about content. The paragraphs were taken from technical material, including texts on naviation, physics, map reading, astronomy, and airplane instruments.

Measures: factor loadings: .48 on verbal comprehension
.31 on visualization (?)
.28 on kinesthetic-spatial-reasoning

RECOGNITION TEST I (SYLLABLES)

Description: The ecaminee must indicate for each syllable in the test list whether or not that syllable was in the list of syllables which he studies previously. 18 syllables were to be recognized from list of 36. One minute of study was allowed. Score was the number correct.

Measures: factor loadings: .21 on rote memory
.24 on visualization (?)

RECOGNITION TEST II (WORDS)

Description: The examinee must indicate for each word in the test list whether or not that word was in the list of words which he heard previously. The words used are two-syllable nouns which are unrelated to each other.

Measures: factor loadings: .53 on rote memory

RECOGNITION TEST III (FIGURES)

Description: The examinee must indicate for each geometric figure or symbol in the test group whether or not that figure was in the group of figures which he studies previously.

Measures: factor loadings: .21 on immediate meaningful memory
.28 on visualization (?)
.26 on visual memory (??)

II. B. Tests, Cognitive, Perceptual, Psychomotor, and Memory dimensions

REPRODUCTION OF VISUAL DESIGNS TEST

Description: After seeing a geometric design on a flash card, the examinee must reproduce that design.

Measures: factor loadings: .22 on perceptual speed
.43 on visualization (?)
.55 on visual memory (??)

SENTENCE COMPLETION TEST

Description: The examinee must learn a group of unrelated sentences so that when he is presented with a sentence with one word omitted he can reproduce the missing word. When studying the sentence, the examinee does not know which word will be omitted.

Measures: factor loadings: .53 on immediate meaningful memory

SENTENCE SPAN TEST

Description: After hearing a sentence, the examinee must reproduce it. The sentences range in length from 18 to 33 syllables.

Measures: factor loadings: .38 on verbal comprehension
.24 on span memory
.28 on auditory memory (?)

SPATIAL ORIENTATION II

Description: Each test page contains a standard aviation map which is sectioned off into twelve squares; below the map are four aerial photographs of portions of the area portrayed in the map. The examinee must match the photographs to the proper sections of the map.

Measures: factor loadings: .43 on perceptual speed
.48 on visualization (?)

VOCABULARY

Description: The examinee must select synonyms for given words.

Measures: factor loadings: .60 on verbal comprehension

179. Kohfeld, L. The prediction of perceptual-motor learning from independent verbal and motor measures. Contract Nonr 1834 (39). Dept. of Psychology, University of Illinois, Urbana, Illinois, April 1966 (AD 635 865)

II. B. Tests, Cognitive, Perceptual, Psychomotor, and Memory dimensions

PERCEPTUAL-MOTOR LEARNING PREDICTION

Subjects: 40 undergraduate males.

Method: The study concerned the prediction of perceptual-motor learning performance from verbal and motor pretests. The motor pretest consisted of 15 one-minute trials on the Two-Hand Coordination Test (THC). Score was the mean time on target. The verbal pretest was a Memory Drum using a list of items (three letter nonsense syllables, each paired with one of two other nonsense syllables) such that a 14-unit T-maze was designed. Score was the mean number of pairs correctly recalled prior to presentation over 15 trials. The criterion learning task was a modified THC. The revolving disc of the THC was inscribed with a 14-choice point T-maze and hidden from the subject's view. A green light indicated a choice point and a red light indicated an incorrect choice. The task was presented as a problem to be solved with no mention of the maze. It was operated with discrete movements using one hand only (hands alternated at each choice point). The time scores for each of 15 trials were obtained.

Results: A factor analysis developed by Tucker of trial-by-trialtime measurement intercorrelations for the learning criterion resulted in two factors, Early and Late Learning. The correlations of the verbal and motor measures with these two factors were:

	Early Learning	Late Learning
Motor	.12	.23
Verbal	.29*	.19

*$p < .05$

The author suggested that sufficient learning trials were not allowed as the correlation of the motor measure with the Late Learning factor for the 17 subjects who reached errorless performance was .45.

II. B. Tests, Cognitive, Perceptual, Psychomotor, and Memory dimensions

180. Loftus, J. P. and Hammer, L. R. Weightlessness and performance. A review of the literature. Aeronautical Systems Division Technical Report 61-66, Behavioral Science Laboratory, Aerospace Medical Laboratory, AF Systems Command, USAF, Wright-Patterson AFB, Ohio, June 1961

PERFORMANCE UNDER WEIGHTLESSNESS

Studies of performance under weightless conditions are reviewed. Summary comments of performance on some particular tests are listed below. The primary references are given by letter and are listed below.

"AIMING" TEST AND WEIGHTLESSNESS (Ref. d)

"Lomonaco found increased muscle tonus and a slight but definite motor incoordination in an aiming test, which diminished during several consecutive runs." (p. 16)

"AIMING" TEST AND WEIGHTLESSNESS (Ref. a)

Test: Subjects thrust at a paper target with a stylus and their errors were measured.

Measures: Eye-hand coordination

Method: Subjects tested under normal gravity, increased gravity and zero g; six trials under each condition.

Results: "tendency for subjects to cluster hits around the bullseye under normal gravity but to hit the target above the center during zero g and below center during increased g. Some adjustment to the zero-g condition was indicated by a steady reduction in the average upward deviation from the bulleyes up to the final (sixth) trial; responses under acceleration did not show such change. Nevertheless, amount of error showed little decrease under any of the three conditions. Their conclusion was that eye-hand coordination is moderately disturbed by weightlessness, but that adaptation is possible."

SWITCH PERFORMANCE AND WEIGHTLESSNESS (Ref. c)

Task: somewhat similar to that in Wade, reference 201.

Result: Decrements in speed and accuracy occurred during weightlessness. Repetition of the task resulted in improvement.

II. B. Tests, Cognitive, Perceptual, Psychomotor, and Memory dimensions

VIGILANCE, DISCRIMINATIVE REACTION TIME AND COMPLEX TASK PERFORMANCE AND WEIGHTLESSNESS (Ref. b)

"Measures of vigilance and discriminative reaction time obtained periodically while the subject was immersed indicated a small but significant deterioration; performance on a complex operator task also showed some decrement after the week of immersion."

"The psychomotor effectiveness of the astronaut will be maintained at an adequate level during prolonged weightlessness, but that psychomotor behavior will be grossly disrupted upon re-entry."

However, only one subject with restricted mobility for an entire week and with undetermined motivation was used.

a. Gerathewohl, S. J., Strughold, H. and Stallings, H. D. Sensomotor performance during weightlessness, eye-hand coordination. Journal of Aviation Medicine, 1957, 27, 7-12.

b. Hartman, B., McKenzie, R. E. and Grayeline, D. E. An exploratory study of changes in proficiency in a hypodynamic environment, Report No. 60-72, USAF School of Aviation Medicine, Brooks AFB, Texas, July 1960.

c. Lomonaco, T., Scano, A., and Rossanigo, F. Comportamento de alcune funzione percettino-motorie durante il passaggio da circa 2 a 0 G ed influenza dell' allenamento. Esperimenti eseguiti con la torne de subgravita (Behavior of some perceptive motorial functions during the transition from about 2 g to zero-g. Effect of training, experiments executed with the subgravity tower). Revista de Medicina Aeronautica e Spaziale (Italian), 1960, 23, 439-456.

d. Lomonaco, T., Scano, A., Strollo, M., and Rossanigo, F. Alcuni dati sperimentali fisic-psichici sugli effetti delle accelerazioni e della subgravita previsti nell' uomo lanciata nello spazio. (Some psycho-physical experimental data on the effects of accelerations and subgravity as predictors for man in space). Revista de Medicine Aeronautica (Italian), 1957, 20, 363-390.

181. Marron, E. The search for basic reasoning abilities - a review of factor analytic studies. Research Bull 53-28, Project No. 503-001-0006, Personnel, Research Laboratory, Human Resources Research Center, Air Research and Division Command, Lackland AFB, Texas, August 1953. (AD 19470)

REASONING ABILITIES - REVIEW OF FACTOR ANALYTIC STUDIES

The author comments, "Many of the authors whose work has been surveyed in this review were sensitive to the distinction between the type of reasoning determined by the form of the test problem and the mode of attack adopted by the individual, but they seemed to find it difficult to handle this distinction within the framework of factor analysis."

The implication can be drawn from the author's discussion that better selection and classification would result from consideration of factors and test problems in terms of three variables: (1) individual methods of approach, as trial-and-error, insightful, and analysis; (2) problems the form of which require a particular ability as induction or deduction; and (3) problem content with respect to field of knowledge, abstractness level, and complexity level.

Considering the factors and the tests of Thurstone, Guilford, and Atkins, among others, he groups them more or less under 3 inductive categories and 2 deductive reasoning categories. The left-over factors which he feels may be the basis for empirical variables are an "organizational reasoning" or "attention" factor, flexibility of closure, and a concept formation factor.

Below are listed the tests with their respective factor loadings according to category. The author provides references for each of the tests.

II. B. Tests, Cognitive, Perceptual, Psychomotor, and Memory dimensions

FLEXIBILITY OF CLOSURE TESTS (IMAGINATIVE)

COPYING: A drawing consisting of four connected straight lines is to be copied in the dotted space to its right, so that all ends of lines in the copied drawing will lie on dots. Loadings found in factor analytic studies: .36, .45

DESIGNS: The subject is presented with 11 pages of designs, each page having 100 designs. The subject checks each design which contains the capital Greek letter Sigma. Loadings found in factor analytic studies: .38, .38

GOTTSCHALDT FIGURES: A small design at the beginning of each row is followed by four complex ones. The task is to mark each of the four complex designs in which the simpler figure is found. Loadings found in factor analytic studies: .30, .41

HIDDEN PICTURES: The subject is required to find six hidden human or animal figures. The test is scored on the basis of time required to find the first five. Loading found in a factor analytic study: .47

TESTS FOR SEQUENTIAL INDUCTION

LETTER GROUPING: The subject is shown four groups of letters with five letters in each group. Three of the groups have something in common; the subject is asked to mark the odd group. Loadings on induction found in factor analytic studies: .36, .37, .42, .50, .38.

LETTER SERIES: Series ranging in length from seven to twenty one letters are presented. The subject is to write the next letter in the series. Loadings on induction found in factor analytic studies: .39, .49, .53, .52, .47.

NUMBER PATTERNS: Five-by-five matrices of single-digit numbers are given, such that the numbers might be read consecutively in some pattern. One number is omitted from each matrix. The missing number is to be indicated. Loadings on induction found infactor analytic studies: .39, .36.

PATTERN ANALOGIES: A selection is made from five choices of the fourth geometrical figure in a proportion, such that the fourth is related to the third as the second is to the first. Loadings on induction found in factor analytic studies: .39, .33

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PROGRESSIVE MATRICES B: Each item shows three discrete figures arranged as three corners of a square. The correct figure for the fourth corner must be chosen from six alternatives. Loading on "hypothesis verification" found in a factor analytic study: .47

PROGRESSIVE MATRICES C: Each item consists of a three-by-three array of figures. The one at the intersection of the third column and third row being chosen by the subject from eight alternatives. Loading on "hypothesis verification" found in a factor analytic study: .57

PROGRESSIVE MATRICES D: The subject must discover the rules by which the same elements recur in each row or column. Loading on "hypothesis verification" found in a factor analytic study: .54.

FIGURE ANALOGIES COMPLETION: Each item contains a pair of figures. The subject must determine what relation the second figure bears to the first and then draw a figure which bears the same relationship to a third figure. Loadings on test of AAF Reasoning II and III, and "nonverbal-nonnumerical reasoning" found in factor analytic studies: .40, .51, .66, .47, .31.

COMPLEX DEDUCTION TESTS

ARITHMETIC REASONING Test 2: Difficult arithmetic problems some of which require a knowledge of algebra.

ARITHMETIC REASONING Test 3: An arithmetic problem test.

ARITHMETIC REASONING Test 4: This test uses arithmetic reasoning items which require a minimum of formal training. Factor loadings found on these three tests in different factor analytic studies:

"Deduction": .49 "Restrictive thinking": .58
"Numerical": .60 "AAF reasoning I": .40, .58

FIGURE ANALOGIES: One of five geometrical figures is to be selected as the fourth term in a proportion so that it bears the same relation to the third as the second does to the first. Factor loadings found on this test in different factor analytic studies:

"Numerical": .49
"AAF Reasoning I": .35, .34, .02

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MATHEMATICS B: This is a combination of Arithmetic Reasoning (C1206B) and Numerical Approximation (C1706A). The first uses arithmetic reasoning items which attain difficulty while requiring only minimal formal training in mathematics. The second is designed to test the ability to check rapidly for gross errors. To minimize the sheer numerical operation component, directions encourage the examinee to estimate the answer roughly not taking time to compute them. Factor loadings found on these tests in different factor analytic studies:
"AAF Reasoning I": .55, .48, .50, .50

NUMBER SERIES: Series of seven numbers each are given, two of which are left for the subject to supply according to a rule which can be determined by examining the other five numbers in the series.

Factor loadings found which relate to Complex Deduction:
"Deduction": .47
"Numerical": .50
"AAF Reasoning I": .36

Factor loadings found which relate to Sequential Induction:
"Induction": .26, .50, not significant in one study, .45.

SEQUENTIAL DEDUCTION TEST

FALSE PREMISES: This test is similar to a standard syllogism test except that the statements are nonsensical. Two premises and a conclusion are presented in each item. Each conclusion is judged true or false. Factor loadings found on this test in different factor analytic studies:
"Hypothesis verification": .30
"Education of perceptual relation": .32
"Deduction" and "Logical Reasoning": .58, .45, .45, .42

ABSTRACT ANALYTIC INDUCTION TEST

VERBAL CLASSIFICATION II: For each set of six test words, two groups of four words each are presented to define two categories. The subject is required to place each of the six test words into one group or the other according to the classification criterion that it fits. This test is like Verbal Classification I except that it is more difficult. Loading on "perception of abstract similarities" found in a factor analytic study: .50

FLEXIBILITY OF CLOSURE TESTS (ANALYSIS EMPHASIZED)

FIGURE CLASSIFICATION IIA: Two groups of three figures each are presented, the figures of each group being alike in some way. For each set, the subject is to classify each of eight additional figures into one of the two groups. Loading on "flexibility of perceptual closure" found in a factor analytic study: .50.

FIGURE CLASSIFICATION IIB: This is similar to Figure Classification IIA except that sets of three groups of three similar figures each are presented, and the subject classifies each of eight additional figures into one of three groups. Loading on "flexibility of perceptual closure" found in a factor analytic study: .44

TWO-HAND COORDINATION TEST

170 students, battery of 43 tests; factor analytic study.

"Flexibility in manipulating configurations" factor loading: .59

182. McFarland, A. The psychological effects of oxygen deprivation (anoxemia) on human behavior. New York: Archives of psychology, No. 145, 1932.

ANOXEMIA EFFECTS ON SIMPLE REACTION TEST, CHOICE REACTION TEST, FORM BOARD TESTS AND PURSUIT METER

SIMPLE REACTION TEST (VISUAL AND AUDITORY): responses not affected until O_2 lowered to 8.87% (24,000 ft). However when O_2 at 10.25% for more than an hour than simple reactions are considerably impaired.

CHOICE REACTION TEST: impairment begins in neighborhood of 11.43% O_2 and worsens with increased deprivation and exposure.

PURSUIT METER TEST: neuro-muscular control on this test is affected more quickly, more accutely, and with more variability then the reaction tests.

FORM BOARD TEST: loss of memory on this test starts to occur when O_2 is lowered to 9.05%

2, 5, & 9 subjects performed the tests under a variety of O_2 deprivations and test combinations.

II. B. Tests, Cognitive, Perceptual, Psychomotor, and Memory dimensions

183. Melton, A. W. (Ed.), Apparatus tests. AAF Aviation Psychology Program Research Reports, Report No. 4, 1947. Washington, D. C.: U. S. Government Printing Office.

The classic summary of the apparatus test program developed during World War II by the United States Army Air Force Aviation Psychology Program with primary emphasis on aircrew selection and placement. Unfortunately, this primary source of details is no longer available.

184. Merrifield, P. R., Guilford, J. P., Christensen, P. R., and Frick, J. W. A factor-analytic study of problem-solving abilities. Contract No. onr-23810. Report No. 22, Psychological Lab., University of So. California, Los Angeles, California, March 1960. (AD 237 752)

CONTINGENCIES TEST AND THE PERTINENT QUESTIONS TEST

Subjects: 219 Naval Air Cadets and Aviation Officer Candidates.

Method: 21 reference marker tests and 12 new tests developed to test problem solving hypothesis were administered to the group. The results were factor analyzed. All of the tests used are briefly described in the article. (Suggest contacting either the authors or the Sheridan Supply Company for copies of the tests)

Results: factors which fit into Guilford's intellect structure model were obtained (CMU, CMI, DMU, EMI, EMR, DMR, CMC, NMR, DMT, NMI, CMS, and NMC). CMI is defined as conceptual foresight or cognition of semantic implications. Two tests, Contingencies and Pertinent Questions, had CMI factor loadings of .45 and .54, respectively.

Contingencies (PX03A): State a condition that might require the use of a given object in a given situation. Score is the number of plausible conditions listed. Test consists of one part with 20 items. Six minutes is allowed.

Pertinent Questions (PR03A): Write questions, the answers to which would seem a basis for making a decision in a given situation. Score is the number of relevant questions. Test consists of two parts with four items per part. The working time is 12 minutes.

II. B. Tests, Cognitive, Perceptual, Psychomotor, and Memory dimensions

185. Moldawsky, S., and Moldawsky, P. C. Digit span as an anxiety indicator. Journal of Consulting Psychology, 1952, 16, 115-118.

DIGIT SPAN TEST AND VOCABULARY TEST AND ANXIETY STRESS (subtests of WECHSLER-BELLEVUE SCALE)

Subjects: 32 psychology students for whom differences between Digit Span score and verbal mean were within 2 points of each other.

Method: four matched groups of 8; 2 experimental, 2 control. Anxiety produced by remarks re: previous poor performance, etc.

Results: drop in score for exp group on Digit Span was -1.125 as compared to .875 gain for control group. Significant at $p < .05$

Comments: Vocabulary test was relatively impervious to this stress, situation anxiety. Authors suggest Digit Span anxiety sensitivity due to its being a learning task.

186. Myers, I., Murphy, B., Smith, S., and Windle, C. Experimental assessment of a limited sensory and social environment: Summary results of the HumRRO Program. Research Memorandum, Task PIONEER VI, US Army Leadership Human Research Unit, Presidio of Monterey, California, February 1962. (AD 653 786)

ISOLATION AND INTELLECTUAL ABILITIES

Subjects: total of 218 recent army enlistees who had volunteered. The subjects for the experiment noted here included 34 experimentals and 34 controls.

Tests: Subjective Stress Questionnaire: the questionnaire is discussed here but none of the specific items are given, only the content areas. It includes 242 items which sampled the subject's experience on possible isolation experiences. Other tests included the SUBJECTIVE STRESS SCALE, and measures of immediate memory, numerical facility, verbal fluency, successive subtraction, and inductive reasoning.

Method and Results: experimentals underwent 96 hours of isolation. The experimentals reported strong subjective feelings of decreased intellectual efficiency during isolation. The intellectual tests were given prior to isolation, after 75 hours of isolation, and after isolation was terminated. The Controls performed significantly better than the experimentals at the .05 level on the successive subtraction and inductive reasoning tests taken at the 75 hour period.

187. Ormiston, D. W., and Finkelstein, B. The effects of confinement on intellectual and perceptual functioning. Aeronautical Systems Division Technical Report 61-577, Aerospace Medical Lab., AF Systems Command, USAF, Wright-Patterson AFB, Ohio, October 1961.

INTELLECTUAL & PERCEPTUAL FUNCTIONING, EFFECTS OF CONFINEMENT

Intellectual tests: Arithmetic Test (10 to measure numerical and reasoning factors aurally presented problems of increasing difficulty), Memory for Digits (immediate recall and concentration), Memory for Confusing Sentences (immediate recall of difficult verbal material), Same-Opposite Word Meanings (level of verbal ability), Verbal Analogies (verbal reasoning), Paired Associates Learning, and Logical Reasoning (judge whether conclusion drawn from set of premises is true or false).

Perceptual tests: Warning Light Monitoring (monitoring alertness), Target Identification Test (fine form discrimination), Embedded Figures Test (perceptual speed and accuracy), Aerial Reconnaissance Test (10 slides of aerial photos with which subject compared a 17 item checklist and reported location of items found).

Also given was a Dual Compensatory Track Task, but data unusable.

Subjects: 20 male AF officer volunteers, aged 23 to 40 years.

Method: subjects confined to a mockup aircraft escape capsule. Experimentals remained in capsule for full 48 hours while Controls were in capsule only for tests and eating. Confined subjects allowed to smoke and to converse with the monitor. Subjects given tests once on first day (started confinement at 2 PM), twice on second day, and once on third day.

Results: No performance decrement occured on intellectual tests, or perceptual tests other than a sig ($p < .005$) interaction of Aerial Reconnaissance with diet, which the authors considered questionable. Of interest was the authors conclusion that "Neither bizarre behavior nor performance decrement are so likely to occur in confined subjects as in sensorily deprived subjects. However, intense fear or panic may occur occasionally."

188. Parker, J. F., Jr. Use of an engineering analogy in the development of tests to predict tracking performance. Office of Naval Research Contract Nonr-3065(00). The Matrix Corp., Arlington, Va., February 1964. (AD 602 861)

TRACKING TASK, CRITERION

Subjects: 100 high school senior and college freshmen and sophomore students.

Method: A factor analytic study attempting to determine the abilities important to the Tracking Task. The reference tests included 3 printed tests, 6 electronic tests, 5 mechanical tests and the Rudder Control test. The criterion measure was the integrated tracking error obtained from 16 training sessions on the Tracking Task, each session comprised of 21 one-minute trials.

Results: Nine oblique factors were derived: movement analysis, time sharing, multilimb coordination, ability to deal with linear extents (tentative), ability to deal with rotational magnitudes (tentative), single integration/differentiation specific, multiplication by a constant (electronic) specific, control precision, and movement prediction. (Note: the factor names are the ones in use at present rather than the names given in the article). A multiple correlation using movement analysis, multilimb coordination, and movement prediction amounted to .479. The loadings of these factors on the criterion Tracking Task performance measure were:

Multilimb Coordination:	.55
Movement Prediction:	.33
Movement Analysis:	.24

Some of the reference tests are described below.

ANALOG ADDITION (ELECTRONIC)

Description: An oscillograph display consisting of a base line with three vertical lines rising from it. The subject must maintain the height of the middle line such that it equals the sum of the heights of the other two continuously changing lines. A joy stick control is used. An integrated error measure is obtained.

Measures: The following factor loadings were found:

Movement analysis:	.22
Control precision:	.31
Single Integ/Diff Spec:	.23

II. B. Cognitive, Perceptual, Psychomotor, and Memory dimensions

DOUBLE DIFFERENTIATION (ELECTRONIC)

Description: An oscillograph display of an accelerating dot. The subject has 3 chances to observe and then correctly set a potentiometer such that a second dot has the same constant acceleration as the first dot. Score is the voltage difference between the subject setting and the programmed setting.

Measures: The following factor loading was found:
Movement analysis: .58

DOUBLE DIFFERENTIATION/INTEGRATION (MECHANICAL)

Description: Subject observes a ball accelerating down an inclined plane. It subsequently disappears behind a screen which has a marked location. The subject must judge when the ball will reach that location behind the location by depressing a button. The score is the time discrepancy.

Measures: The following factor loading was found:
Movement prediction: .43

MULTIPLICATION BY A CONSTANT (ELECTRONIC)

Description: An oscillograph display of a constant velocity dot. The subject has three opportunities to observe the dot and then to correctly set a potentiometer such that a second dot will move at two or three times the velocity of the first dot. Score is the voltage difference between the subject setting and the programmed setting.

Measures: The following factor loadings were found:
Movement analysis: .21
Multiplication by a constant (electronic) specific: .41

TIME SHARING (ELECTRONIC)

Description: The subject first practices keeping a dot centered on one oscilloscope. He is then presented with two oscilloscopes; the dot moves horizontally on one scope, vertically on the other. The subject must attempt to keep the dot centered on each scope simultaneously using a single control stick.

Measures: The following factor loading was found:
Movement prediction: -.30

II. B. Tests, Cognitive, Perceptual, Psychomotor, and Memory dimensions

TIME SHARING TEST (MECHANICAL)

Description: The subject was presented initially with a single display unit consisting of two red lights. His task was to depress a switch when both red lights were on but not when 2 single lights appeared. A standard timer recorded response latency. For the second part of the test, the display consisted of three units in a vertical array each separated by 18 inches. Again, the subject was to depress a switch upon the appearance of both red lights. However, now both red lights might appear at any one of the three positions. Therefore, all three had to be monitored, simultaneously. The score was the ratio of his performance in the time sharing situation to his performance when time sharing was not required.

Measures: Loading of the factor, time sharing of visual information, was .79.

TIME SHARING TEST (PRINTED)

Subjects:

Description: Test consisted of two parts. In the first part, the subject traced down a single column of numbers, crossing through only those which contained identical digits. In the second part, two columns of numbers were presented which were separated by about $1\frac{1}{2}$ inches. The subject traced down both columns simultaneously in order to identify the proper combination through which to mark. The score was a ratio representing the percentage of decrease in performance in the second part over that shown in the first part.

Measures: Loading of the factor, time sharing of visual information, was .71.

SINGLE DIFFERENTIATION (ELECTRONIC)

Description: Oscillograph display of a constant velocity dot. The subject has three opportunities to observe and then match the speed of the first dot with a second dot using a potentiometer setting. Score is the voltage difference between the subject setting and the programmed setting.

Measures: The following factor loading was found:
Movement analysis: .60.

II. B. Tests, Cognitive, Perceptual, Psychomotor, and Memory dimensions

189. Parker, J. F., and Fleishman, E. A. Ability factors and component performance measures as predictors of complex tracking behavior. Psychological Monographs, 1960, 74, whole no. 503, 1-36.

Also available in:

Parker, J. F., and Fleishman, E. A. Prediction of advanced levels of proficiency in a complex tracking task. WADC Tech. Report 59-255, Contract AF41(657)-64, Aerospace Med. Lab., Wright Air Development Div., Air Research and Development Command, USAF, Wright-Patterson AFB, Ohio, December 1959. (AD 236 907)

TRACKING TASK, CRITERION

Subjects: 203 freshmen and sophomore Air Force ROTC students

Method: a test battery of 23 apparatus and 21 printed tests was administered (drawings and descriptions are given). The criterion learning task was a complex tracking device described as follows: "...constructed so as to simulate roughly the display characteristics and control requirements of an airborne radar intercept mission. The task of the subject was to maintain the target dot at the center of the oscillograph display, while at the same time nulling a sideslip indicator. That is, the subject envisioned himself to be flying the attack phase of an airborne radar intercept mission. Thus, if the target was to the right, the subject made appropriate control movements to steer the craft to the right. These movements would bring him "on target" and the dot would return to the center of the display. All turning movements required coordinated action of stick and rudder controls." (p. 5) The block diagram and schematics for the tracking task components and a photograph of the device are included in the article (1959 only). Reaction to the target dot involved acceleration control and velocity control. Four error and one time-on-target performance scores were obtained for 21 one-minute trials on each of 17 practice sessions per subject. The first three scores for each session were discarded. Ten stages of practice were used in the factor analysis.

Results: 15 ability factors emerged from the factor analysis (onr nos. 19, 31, 33, 34, 36, 37, 38, 39, 45, 48, 54, 55 and integration pursuit

confusion doublet, and mechanical experience) of which only three loaded at all on the criterion tracking task and accounted for no more than 25% of the variance at any stage of practice on the integrated error score. The three factors each became more important at a different set of practice stages across all the performance scores. Multilimb coordination was most evident during the last practice stages (maximum loading was .30). Response orientation loaded highest on the middle practice stages (maximum was .25). The Spatial orientation correlations were more complex. It loaded maximally on the initial and middle stages of practice (.30 maximum) for the integrated error score and the vertical error score. On the horizontal error score and the time-on-target score, however, it tended to load across all stages of practice with the maximum loadings occurring in the middle and in the last stages (.27 maximum). (The maximal loading of Spatial Orientation on sideslip error was only .12).

The following are experimental test data and descriptions which appear in the article.

RELIABILITIES - APPARATUS PSYCHOMOTOR TESTS

Bimanual matching (Two-Hand Matching)	.74 (split-half)
Choice Reaction Time	.68 (split-half)
Complex Coordinator	.85 - .95
Discrimination Reaction Time (Printed)	.87 - .96
Minnesota Rate of Manipulation	.87 (placing), .79 (turning)
Motor Judgment	.56 (split-half)
O'Connor Finger Dexterity	.76
Precision Steadiness (errors)	.90
Purdue Pegboard (summation score)	.90 (average, corrected for test length)
Pursuit Confusion	.90 (errors), .88 (corrects)
Rate Control	.89
Reaction time, Visual	.86, .88 (jump)
Reaction time, Auditory	.85, .88 (jump)
Rotary Aiming	.96
Rotary Pursuit	.92 - .97
Rudder Control	.90 - .92
Ten Target Aiming	.94 (errors), .91 (corrects)
Track Tracing (errors)	.91
Two-Hand Coordination	.89 - .93

Discrimination Reaction time	.87
General Mechanics	.88
Instrument Comprehension	.92
Pattern Comprehension	.76
Speed of identification	.74
Visual Pursuit	.80

AERIAL ORIENTATION

Description: Subject is required to match the cockpit view of the horizon that corresponds to the airplane from which this view would be seen. This is a printed test.

Data: Reliability: .84

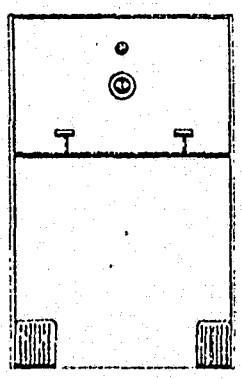
Measures: Spatial orientation factor loading of: .52

CHOICE REACTION TIME

Description: The subject is confronted with a panel containing a central light. He has two levers, one for the right hand and one for the left hand, and two foot pedals. He responds appropriately to any of four stimuli as follows:

red light-right lever forward
green light-left lever back
buzzer-right pedal depressed
bell-left pedal depressed

The subject is allowed 3 seconds in which to respond. The central light extinguishes when the correct response is made.



Data: Split-half reliability is .68.

Measures: Factor loadings of: .12 on Reaction Time
.39 on Response Orientation
.25 on Arm-Hand Coordination

COMPLEX MOVEMENTS

Description: a printed test. Each problem presents a vertical line and above it a horizontal line. On each of these lines is a circle and a dot. Below the lines is a grid of 49 squares, one of which

contains an "S". The examinee indicates in the grid from the letter S the direction required to "move" the dots on both lines' simultaneously into their respective circles.

Data: Reliability is .85.

Measures: Factor loadings of: .34 on visualization
.30 on integration

CONTROL ADJUSTMENT (also called CONTROL SENSITIVITY)

Measures: Factor loadings of: .38 on Control Precision
.29 on Reaction Time
.26 on Mechanical Experience

COORDINATE MOVEMENTS

Description: a printed test. Each problem presents a series of arrows which vary in curvature and represent different directions of movement. The thickness of each arrow represents distance of movement. To the left of these arrows are a dot and circle. The subject selects the one symbol (arrow) that will move the dot inside the circle.

Data: reliability is .70.

Measures: Factor loadings of: .36 on Spatial Orientation
.40 on Integration

DIRECTIONAL CONTROL

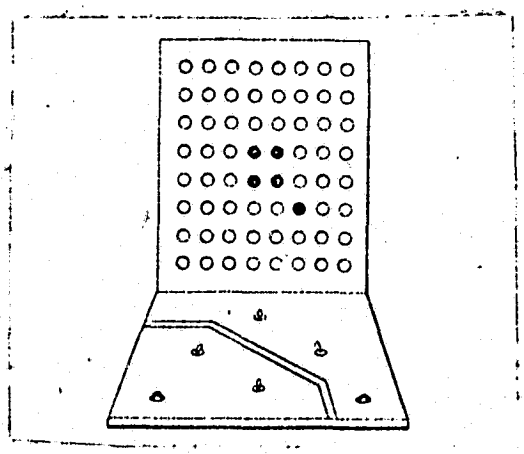
Description: a printed test. Each problem presents nine boxes side-by-side with a target circle above the middle box. Also pictured is an arrow whose head indicates direction and whose length indicates distance of movement. The subject indicates from which box it must be launched to have its head reach the target.

Data: reliability is .85

Measures: Factor loadings of: .34 on Spatial Orientation
.27 on Response Orientation
.30 on Integration

II. B. Tests, Cognitive, Perceptual, Psychomotor, and Memory dimensions

DIRECTION CONTROL



Description: Patterns of lights appear in the form of a cross (to indicate the "heading" of an airplane). The pattern may appear in different parts of the display panel and may represent a small or large cross, depending upon the direction of heading. The examinee must use both hands concurrently in manipulating the proper combination of switches or switches and buttons. A new aircraft appears upon proper manipulation. Four 2-minute trials.

Data: (score of corrects) reliability of .90 to .95.

Measures: factor loadings:

Visualization	.34
Spatial orientation	.24
Response orientation	.23

FOLLOWING DIRECTIONS

Description: Two panels of typical aircraft display instruments are presented to the subject. As the subject reads the text he underlines certain words depending on upon relations among the instruments and upon directions appearing within the text. The test is designed to measure ability to work rapidly under the pressure of complex directions.

Data: reliability is .75

Measures: factor loadings of

Perceptual Speed	.31
Spatial Orientation	.27
Integration	.27

FORCED LANDINGS

Description: a printed test. Aircraft are depicted at certain altitudes above a number of boxes representing landing fields. Arrows are also shown on the display representing wind direction and magnitude and up or down draft currents. The subject must assess the situation and select the best landing field in terms of prescribed criteria.

Data: reliability is .88 - .91

Measures: Factor loadings of:

Response Orientation	.36
Mechanical Experience	.35
Spatial Orientation	.29

FORMATION VISUALIZATION

Description: a printed test. The subject is presented with the top and side view of silhouettes of aircraft flying an formation. He then must select the correct alternative from among four front views of this same formation flight.

Data: reliability of .76

Measures: Factor loadings of:

Spatial Orientation	.33
Visualization	.61

MECHANICAL COMPREHENSION TEST

Description: The subject is presented drawings of mechanical devices. He then must answer a series of questions concerning the operation of each device.

Data: reliability of .82

Measures: factor loadings of:

Spatial Orientation	.32
Visualization	.38
Mechanical Experience	.47

SIGNAL INTERPRETATION

Description: The subject is presented with a picture of a row of ships, each ship having an arrow beneath it. The subject traces from ship to ship in accordance with the pattern of flags being flown by each ship. Each problem continues until the subject returns to a ship used previously.

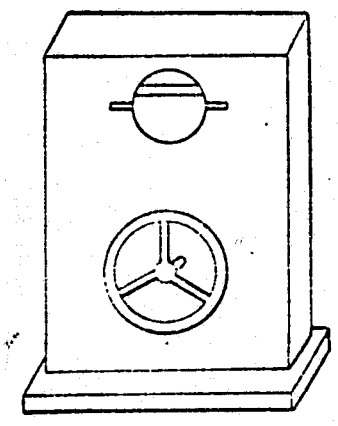
Data: reliability of .77

Measures: factor loadings of:

Spatial orientation	.45
Response orientation	.30

II. B. Tests, Cognitive, Perceptual, Psychomotor, and Memory dimensions

SINGLE DIMENSION PURSUIT METER



Description: The subject makes compensatory adjustment (in and out movements) of a control wheel in order to keep a horizontal line in a null position as it deviates from center in irregular fashion. The control wheel is damped pheumatically, introducing a lag into the system. Score is the time the horizontal line is held in a null position during the four 1-minute trials.

Data: reliability of .84 to .92

Measures: factor loading of:

Arm-Hand Steadiness	-.26

SPATIAL ORIENTATION TEST

Description: The subject is presented with a large aerial photograph. This is followed by several small photographs, each presenting an expanded view of one section of the large photograph. The subject must connect each small photograph with the proper position within the large photograph.

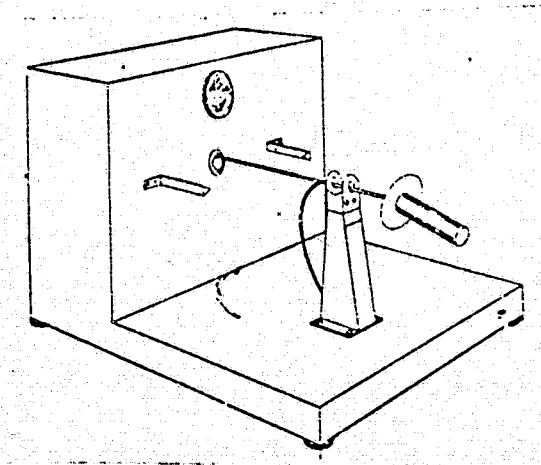
Data: reliability of .69

Measures: factor loadings of:

Spatial orientation	.34
Manual dexterity	.27
Perceptual speed	.30

STEADINESS AIMING

Description: The subject must keep a delicately balanced stylus centered in a small hole. Any contact with the sides of the hole is recorded on a clock. The score is the number of seconds in contact. Six 40-second trials.



Data: reliability is .84.

Measures: factor loading of:

Arm-Hand Steadiness	.40

II. B. Tests, Cognitive, Perceptual, Psychomotor, and Memory dimensions

STICK & RUDDER ORIENTATION

Description: A series of pictures is presented to the subject showing changing views through the windscreen of an aircraft. The subject is required to recognize the corresponding change in the position of the aircraft and to indicate the movements of stick and rudder required to produce such a change.

Data: reliability of .74

Measures: factor loadings of:

Spatial orientation	.53
Visualization	.57

TWO-HAND MATCHING (also called BIMANUAL MATCHING)

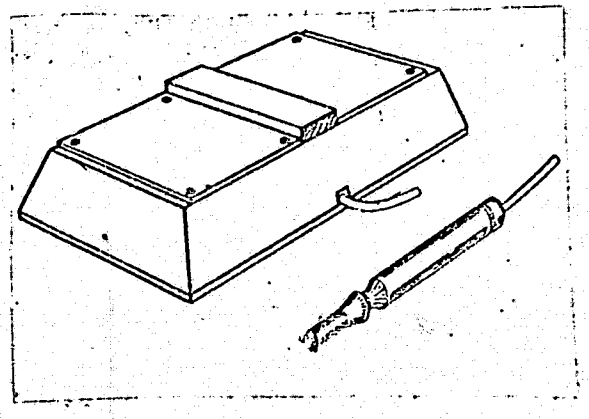
Data: Split-half reliability is .74

Measures: factor loadings on:

Spatial orientation	.33
Speed of Arm movement	.37
Response orientation	.14

TWO-PLATE TAPPING

Description: The subject is required to strike two adjacent metal plates with a stylus as rapidly as possible. He strikes the plates successively; that is, first one and then the other, making as many taps as possible on the plates in the time allowed. The number of taps is recorded on counters. Three 30-second trials.



Data: reliability is .99

Measures: factor loadings of:

Manual dexterity	.35
Speed of Arm movement	-.05
Control precision	.41

VISUALIZATION OF MANEUVERS

Description: A picture of an aircraft is presented. This is followed by three descriptions of changes in the aircraft position. The subject then selects from among five alternatives that picture of the airplane which represents its final position following the described maneuvers.

Data: reliability of .87

Measures: factor loadings of:

Spatial orientation	.46
Visualization	.47

WORD KNOWLEDGE

Description: typical vocabulary test requiring the matching of words and definitions.

Data: reliability of .90

Measures: factor loading of:

Verbal comprehension	.67

190. Parker, J. F., Jr., Reilly, R. E., Dillon, R. F., Andrews, T. G., and Fleishman, E. A. Development of tests for measurement of primary perceptual-motor performance. NASA CR-335, December, 1965.

The purpose of this project was to develop a prototype battery of tests suitable for measuring the primary dimensions of perceptual-motor performance. An extensive survey was made of the factor analytic investigations of perceptual-motor performance. Based on results of this survey and a consideration of the kinds of activities likely to be required of crewmen in space vehicles, eighteen basic perceptual-motor abilities were selected. An integrated console was developed which would provide separate measures for each of these performance dimensions. The console is seen to be of value in assessing the influence of the space environment on human performance.

The report provides a test catalogue for the psychomotor dimensions which includes a listing of references and obtained factor loadings. The loadings for some of these tests are given below. The alpha characters refer to the primary references which are listed at the conclusion of the tests.

AUDITORY REACTION TIME

Measures: factor loadings as follows:

Ref no	Reaction Time
b	.68
k	.68
m	.51

II. B. Tests, Cognitive, Perceptual, Psychomotor, and Memory Dimensions

COMPLEX COORDINATION TASK

Measures: factor loadings as follows:

Ref Nos	Control Prec	Multilimb Coord	Response Orient	Spatial Orient	Spd of arm Mvmt	Visualization
b	.36				.09	
c	.45		.44	.13	.37	
d			.43	.40		
f	.35	.30	.09		.21	
g	.44			.46	.09	
i	.47			.39 (early)	.37	.38 (early)
j	.50		.22	.16		
k				.45		
n		.38	.23	.34	.09	

Note: some of the loadings, as given, are for early trials, while some of the others are for late trials.

DISCRIMINATION REACTION TIME (MECHANICAL)

Measures: factor loadings:

Ref Nos	Speed of arm Movement	Manual Dext	Response Orient	Spatial Orient	Visualization
b	.05	.10			
c	.46		.28	.38	.16
d			.53	.38	
f	.03		.67		
g	-.03			.72	
i	.25			.52	.23
j		.34	.50	.37	.10
k				.33	
n	.07	.01	.29	.14	.34

DISCRIMINATION REACTION TIME (PRINTED)

Measures: factor loadings

Ref nos	Manual dexterity	Perceptual Speed	Response orientation	Wrist-Finger speed
b	.26			.14
d			.42	
f			.52	
h	.34			.30
i		.35		
j	.04		.41	
n	.15	.14	.38	

II. B. Tests, Cognitive, Perceptual, Psychomotor, and Memory dimensions

GENERAL MECHANICS TEST

Measures: factor loadings:

Ref nos	Mechanical experience	Visualization
c	.64	.09
g	.81	
i	.62	.06
n	.47	.38

INSTRUMENT COMPREHENSION TEST

Ref nos	Spatial orientation	Mechanical experience	Perceptual speed
c	.49	.19	.29
d	.69		
g	.50	.41	.15
i	.46	.16	.35
k	.37		
n	.47	.16	.15

JUMP AUDITORY REACTION TIME

Measures: factor loadings:

Ref nos	Reaction Time	Speed of Arm Movement
k	.70	
n	.48	.31

JUMP VISUAL REACTION TIME TEST

Measures: factor loadings:

Ref nos	Reaction Time	Speed of arm movement
b	.73	.19
c		.65
f	.54	.54
g		.40
i		.54
k	.73	
n	.52	.36

MARKING ACCURACY

Measures: factor loadings:

Ref nos	Aiming	Spatial orientation	Finger Dext.	Manual Dext.
b	.37		.31	.32
g	.40			
i		.35		
n		.34	.36	.38
h			.37	.53
a				.73

II. B. Tests, Cognitive, Perceptual, Psychomotor, and Memory dimensions

MECHANICAL PRINCIPLES TEST

Measures: factor loadings:

Ref nos	Mechanical experience	Verbal comprehension	Visualization
c	.61		.40
d			.41
i	.49		.41
k		.43	

MINNESOTA RATE OF MANIPULATION TEST, PLACING AND TURNING

PLACING

Measures: factor loadings as follows:

Ref nos	Manual dexterity	Finger dexterity	Speed of arm movement
a	.73		
b	.32	.31	.36
h	.53	.37	.24
n	.38	.36	-.13

TURNING

Ref nos	Manual dexterity	Finger dexterity
a	.61	
b	.38	.34
h	.52	.34
n	.40	.18

O'CONNOR FINGER DEXTERITY

Measures: factor loadings:

Ref nos	Finger dexterity	Manual dexterity	Visual Feedback
a		.50	.43
b	.53	.25	
h	.59		
n	.49		

PATTERN COMPREHENSION TEST

Measures: factor loadings:

Ref nos	Visualization	Perceptual Speed	Spatial Orientation	Verbal Comprehension
c	.60	.36	.31	
d	.55		.40	
i	.60	.23	.33	
k			.24	.46
n	.58			.16

II. B. Tests, Cognitive, Perceptual, Psychomotor, and Memory dimensions

PRECISION-STEADINESS TEST

Measures: factor loadings as follows:

Ref Nos	Arm-Hand Steadiness
b	.50
e	.56
f	.43
n	.34

PURDUE PEGBOARD, SUM OF SCORES

Measures: factor loadings based on the sum of scores on assembly, both hands, left hand, and right hand:

finger dexterity	.43
manual dexterity	.33

PURDUE PEGBOARD--ASSEMBLY TASK

Measures: factor loadings:

Ref nos	Finger Dexterity	Manual Dexterity
b	.55	.21
g	.43	.31
h	.59	.32
k	.35	

PURDUE PEGBOARD--BOTH HANDS TASK

Measures: factor loadings:

Ref nos	Finger dexterity	Manual dexterity
a		.63
b	.61	.21
h	.66	

PURDUE PEGBOARD--LEFT HAND TASK

Measures: factor loadings

Ref nos	Finger dexterity
b	.58
h	.55

PURDUE PEGBOARD--RIGHT HAND TASK

Measures: factor loadings:

Ref nos	Finger dexterity
b	.46
h	.60

B. Tests, Cognitive, Perceptual, Psychomotor, and Memory dimensions

PURSUIT CONFUSION - TOT AND ERRORS

Measures: factor loadings:				
Ref nos		Pursuit Conf	Rate Control	Arm-hand Steadiness
TOT	Control precision	Doublet		
f	.12	.24	.37	.11
j	.48		.17	
n	.38	.35		
ERRORS				
f	.04	.31	.19	.36
n	.37			-.04

RATE CONTROL

Measures: factor loadings:				
Ref nos	Rate Control	Control precision	Spatial orientation	Reaction time
f	.30	.30		.29
g	.72	.01	.17	
j	.58	.24		
n			.47	

RATE OF MOVEMENT TEST

Measures: factor loadings:	
Ref nos	Speed of arm movement
c	.42
g	.40
k	.48

ROTARY AIMING

Measures: factor loadings:			
Ref nos	Speed of arm movement	Aiming	Wrist-finger speed
b	.46		.36
f	.38		
g	.53		
h		.22	
l		.38	
n	.02		

ROTARY PURSUIT

Measures: factor loadings:

II. B. Tests, Cognitive, Perceptual, Psychomotor, and Memory dimensions

Ref nos	Control Precision	Manual Dexterity	Speed of arm movement
b		.17	.22
c	.26		.47
f			.17
g	.49		.20
i			.34
j		.35	
n	.60	-.06	-.02

RUDDER CONTROL - TRIPLE TARGET

Measures: factor loadings:

Ref nos	Multilimb Coord	Mvmt Prediction	Control Precision	Single Integ/ Diff Specific	Doublet
b			.45		
f	.48		.48		.46
j			.40		
m	.36	.23	.52	.21	
n			.40		

SANTA ANA FINGER DEXTERITY

Measures: factor loadings:

Ref nos	Manual Dexterity	Aiming	Finger Dexterity	Spatial Orientation
b	.47		.16	
g		.17	.42	.39
j	.38			-.07
k	.38		.46	.20
l	.28	.33	.06	

SPEED OF IDENTIFICATION TEST

Measures: factor loadings:

Ref nos	Visualization	Finger Dexterity	Perceptual Speed	Spatial Orient	Verbal Compre
c	.38		.46	.37	
d			.43		
g		.33	.45	.32	
i	.29		.47	.35	
k			.51	.16	.37
n	.06	.10	.53		.20

II. B. Tests, Cognitive, Perceptual, Psychomotor, and Memory dimensions

SQUARE MARKING TEST

Measures:	factor loadings as follows:	
Ref nos	Wrist-finger speed	Aiming
b	.29	.30
h	.46	.31
l		.71

TEN TARGET AIMING-CORRECTS

Measures:	factor loadings as follows:		
Ref nos.	Speed of arm movement	Aiming	Manual dexterity
b	.66		.05
h	.72	.31	
n	.50		.42

TEN TARGET AIMING-ERRORS

Measures:	factor loadings as follows:	
Ref nos	Speed of arm movement	Manual dexterity
b	-.35	.43
h	-.70	
n	.63	.35

TRACK TRACING

Measures:	factor loadings:	
Ref nos	Arm-hand steadiness	Finger dexterity
b	.61	.21
e	.61	
f	.50	
g		.35
n	.42	.18

TWO-HAND COORDINATION

Measures:	factor loadings:		
Ref nos	Multilimb coordination	Control precision	Rate control
f	.33	.25	.32
j		.46	.17
n	.30		

VISUAL PURSUIT TEST

Measures: factor loadings:

II. B. Tests, Cognitive, Perceptual, Psychomotor, and Memory dimensions

Ref nos	Perceptual Speed	Control Precision	Spatial Orientation	Integration
c	.46	.24	.17	
g	.28	.36	.22	
i	.50	.20		
n	.35		.35	.33

VISUAL REACTION TIME

Measures: Ref nos	factor loadings: Reaction Time
k	.72
n	.48

a. Bourassa, G. L. and Guion, R. M. A factorial study of dexterity tests. Journal of Applied Psychology, 1959, 43, 199-204.

b. Fleishman, E. A. Dimensional analysis of psychomotor abilities. Journal of Experimental Psychology, 1954, 48, 437-454.

c. Fleishman, E. A. A comparative study of aptitude patterns in unskilled and skilled psychomotor performances. Journal of Applied Psychology, 1957, 41, 263-272.

d. Fleishman, E. A. Factor structure in relation to task difficulty in psychomotor performance. Educational and Psychological Measurement, 1957 17, 522-532.

e. Fleishman, E. A. An analysis of positioning movements and static reactions. Journal of Experimental Psychology, 1958, 55, 13-24.

II. B. Tests, Cognitive, Perceptual, Psychomotor, and Memory dimensions

f. Fleishman, E. A. Dimensional analysis of movement reactions. Journal of Experimental Psychology, 1958, 55, 438-453.

g. Fleishman, E. A. Abilities at different stages of practice in rotary pursuit performance. Journal of Experimental Psychology, 1960, 60, 162-171.

h. Fleishman, E. A., and Ellison, G. D. A factor analysis of fine manipulative tests. Journal of Applied Psychology, 1962, 46, 96-105.

i. Fleishman, E. A., and Hempel, W. E. Changes in factor structure of a complex psychomotor test as a function of practice. Psychometrika, 1954, 19, 239-252.

j. Fleishman, E. A., and Hempel, W. E. Factorial analysis of complex psychomotor performance. USAF Personnel Train. Res. Cent. Res. Rep., No. 54-12, 1954.

k. Fleishman, E. A., and Hempel, W. E. The relation between abilities and improvement with practice in a visual discrimination reaction test. Journal of Experimental Psychology, 1955, 49, 301-312.

l. Hempel, W. E., and Fleishman, E. A. A factor analysis of physical proficiency and manipulative skill. Skill Components Research Laboratory, Lackland AFB, Texas, Research Bulletin, Report AFPTRC-TR-54-34, 1954. (Also in Journal of Applied Psychology, 1955, 39, 12-16).

m. Parker, J. F. Use of an engineering analogy in the development of tests to predict tracking performance. The Matrix Corporation under Office of Naval Research Contract Nonr-3065(00), 1964.

II. B. Tests, Cognitive, Perceptual, Psychomotor, and Memory dimensions

n. Parker, J. F. and Fleishman, E. A. Ability factors and component performance measures as predictors of complex tracking behavior. Psychological Monograph, 1960, 74, 1-36.

191. Price, Helen G. Anxiety and failure as factors in the performance of motor tasks. Research Bull. 52-34, Human Resources Development Center, Lackland AFB, San Antonio, Texas, December 1952. (AD 3779)

ANXIETY, STRESS AND FAILURE AFFECTS ON MOTOR TASK PERFORMANCE

Subjects: 90 women students in college of nursing or college of education who scored in the highest or lowest 20% on Taylor MAS. There were 45 Hi and 45 Low anxiety subjects.

Method: Each of the anxiety groups was split into three groups of 15 subjects each and assigned to one of three conditions: (1) 20 trials on the standard setting Turret Pursuit Apparatus followed by neutral instructions on the criterion task, 20 trials on the Epicyclic Pursuit Rotor; (2) 20 trials on Turret followed by verbal failure instructions on criterion task; (3) 20 trials on Turret with reversed settings, which made the task very difficult, followed by neutral instructions on the criterion task. The author wished to test hypothesis re: facilitative and interference tasks and the anxiety drive.

Results: As the author suggests, the standard setting Turret task was not as easy, or facilitative, for her female subjects as she had expected. This may be the reason why the tested hypotheses were not supported by the results. There was also essentially no difference between the neutral instruction groups and the failure instruction groups as hypothesized. If, however, the following task descriptions are accuracte for the subject population then the results, the mean performances, are interesting and suggestive: Standard setting Turret task-relatively easy, Reversed setting Turret task-very difficult, Pursuit Rotor-moderately difficult. These descriptions are derived from the author's descriptions and evaluations.

TASK, GROUP	HI ANX Ss	LO ANX Ss	diff.	$\frac{\text{diff} \times 100}{\%\text{diff.}=\text{LO ANX Ss}}$
Standard Turret, Grp (1)	4.25	4.54	.29	6%
Pursuit Rotor, Grp (1)	4.61	5.54	.93	17%
Pursuit Rotor, Grp (3)	4.77	5.95	1.18	20%
Reversed Turret, Grp (3)	.14	.29	.15	52%

The above figures are the mean time-on-target scores for the last five trials.

II. B. Tests, Cognitive, Perceptual, Psychomotor, and Memory dimensions

192. Reilly, Raymond E., and Parker, James F.,Jr. Development of an improved perceptual-motor performance measurement system. NASA Contract No. NASW-1329. Biotechnology, Inc., 3219 Columbia Pike, Arlington, Virginia. August 1967. (N67-40317)

ACCELERATION CONTROL

Description: This is one of the 18 tests found in Reilly & Parker's performance panel. It is a one-hand, two-axis compensatory tracking task using second-order system dynamics. The subject's tasks is to keep a target dot centered on the face of the CRT by manipulating a control stick in two axes. Performance is scored as the time integral of the absolute value of error voltage computed separately for each axis and shown on the experimenter x- and y-meters.

MIRROR TRACING

Description: This is one of the 18 tests found in Reilly and Parker's performance panel. The test requires the subject to make directional arm-hand movements when visual information is inverted by a mirror. A metal maze is placed on the subject's console against the spring-loaded electrical contact. The subject's task is to trace the maze in a clockwise direction using the stylus, while viewing the maze in the mirror contained in the visor. Time required to complete the maze one time is obtained manually. Contacts made with the metal portion of the maze when the stylus is moved off of the path, are recorded automatically on the counter. Score is the time required to complete the maze and the number of errors (contacts) made.

193. Schmitz, Melvin, A. The effect of low frequency, high amplitude whole body vertical vibration on human performance. Progress Report No. 2a, January 31, 1958 to January 31, 1959. Bostrom Research Lab., Contract No. DA-49-007-MD-797, Milwaukee, Wisconsin. (AD 218 201)

VIBRATION EFFECTS ON VISUAL ACUITY, HAND TREMOR, COMPENSATORY TRACKING, FOOT PRESSURE, CONSTANCY, FOOT REACTION TIME and BODY SWAY: DRIVING TASK, SIMULATED AND LANDOLT C RINGS

Subjects: 18 college males, aged 19 to 26 years.

II. B. Tests, Cognitive, Perceptual, Psychomotor, and Memory dimensions

Method: The subjects were tested under five conditions: 3.5 cps at .15 g, 2.5 cps at .18g, 3.5 cps at .30g, 2.5 cps at .35g, and a control condition. Two sessions were used for test administration for each of the stress conditions. The test of compensatory tracking, foot pressure constancy, and foot reaction were combined into a simulated driving task. 90 min. of the simulated driving test under vibration were both preceded and followed by 15 min. of the simulated driving test and the body sway and hand tremor tests. A full description of each test apparatus is included in the report.

Results: Analysis of variance is used to test between intensity levels, and between trials.

Hand tremor, frequency and magnitude	Not significant
Body sway	Not significant
Visual acuity	Between intensity levels, sig at $p<.01$
Compensatory tracking (vibration trials)	Between intensity levels, sig at $p<.01$
Foot pressure (vibration trials)	Between intensity levels, sig at $p<.01$
Foot reaction time (vibration trials)	Between trials, sig at $p<.01$ (No apparent cause for this result)

194. Simons, A. K., and Schmitz, M. A. The effect of low frequency, high amplitude whole body vibration on human performance. Contract No. DA-49-007-MD-797, Progress Report No. 1, April 1, 1957 to January 31, 1958. Bostrom Research Lab. (AD 157778)

VIBRATION EFFECTS ON TAPPING RATE, VISUAL CHOICE HAND REACTION TIME, BODY SWAY, MENTAL ADDITION, DEPTH PERCEPTION, VISUAL ACUITY, TRACKING and FOOT PRESSURE CONSTANCY: DRIVING TASK, SIMULATED, LANDOLT C RINGS AND MODIFIED HOWARD-DOHLMAN APPARATUS

Subjects: Males, aged 19 to 34. 5 engineers and 5 shop laborers.

Method: Each subject was tested under three conditions in random order. The conditions were: (1) vibration of 2.5 cps and 1/2 inch amplitude giving an intensity level of .17 g acceleration, (2) 3.5 cps and 1/2 inch amplitude giving an intensity of .31 g and (3) a control condition with no vibration.

A full description of each test apparatus is reported. The foot pressure and tracking tests are included in a simulated driving task. Two other tests were given but their data were not usable.

Results: Significant performance differences were found for the following tests: hand reaction time, $p<.05$; body sway, $p<.01$; depth perception, $p<.01$; visual acuity, $p<.01$; tracking, $p<.01$; foot pressure constancy, $p<.01$. No significant differences were found for the tapping rate or for the mental arithmetic tests.

195. Stopol, M. S. The consistency of stress tolerance. Journal of Personality, 1954, 23, 13-29.

DIGIT-SYMBOL TEST, FAILURE AND DISTRACTION STRESS

Subjects and method: Rorschach and Digit-Symbol Test trial series were given to 48 subjects in 2 sessions. Second session consisted of 2 periods, each involving a prestress, a stress, and a poststress phase. 24 subjects received failure stress initially, followed by distraction (bells, buzzer and flashing light) stress, while 24 subjects experienced distraction stress initially, followed by failure stress.

Results: tolerance refers to the relative decrement of performance on the Digit Symbol test. (1) tolerance for failure stress and for distraction stress are independent of each other. (2) amount of poststress recovery is positively related to the degree of failure and distraction stress tolerance. (3) During second administration of stress there is a greater decrement in performance, regardless of the nature of the stress. (4) Variability of performance during the poststress phase is inversely related to the degree of tolerance for failure stress and distraction stress during the second introduction of stress.

196. Teichner, W. H., and Wehrkamp, R. F. Visual-motor performance as a function of short-duration ambient temperature. Journal of Experimental Psychology, 1954, 47 (6), 447-450.

PURSUIT METER TASK

Koerth-type pursuit rotor with pressureless stylus. Time on target measured.

Subjects: 30 army enlisted men.

Method: 15 trials, 20 seconds each, 10 second interval for 5 days. Performance competition between subjects. Subjects distributed as follows: 55°F - 5 Ss, 70°F - 8 Ss, 85°F - 5 Ss, 100°F - 5 Ss.

Results: performance poorer above and below 70° especially at 100°F.

197. Thomas, F. H. Low altitude aerial observation: An experimental course of instruction. Hum-RRO Technical Report 80, October 1962.

SPEED OF IDENTIFICATION TEST

The Speed of Identification Test score correlated (r = .61) with successful aerial observer performance when the targets tended to be concentrated in a small area.

198. Thornton, C. L., Barrett, G. V., and Davis, J. A. Field dependence and target identification. Human Factors, 1968, 10 (5), 493-496.

EMBEDDED FIGURES TEST

The authors correlated several performance criteria for a target identification task using aerial photographs with a perceptual style measurement, the Embedded Figures Test. The correlations were high (.55 to .72) and two were significant (at the .02 and .05 levels) for a population of ten subjects with a mean age of 30.6 years.

199. Triandis, H. C., Bass, A. R., Ewen, R. B., and Mikesell, Eleanor H. Team creativity as a function of the creativity of the members. Technical report no. 6, Office of Naval Research Contract NR 177-472, Nonr 1834136. University of Illinois, Urbana, Illinois. April, 1962. (AD 282366)

TEAM CREATIVITY AS A FUNCTION OF MEMBER CREATIVITY

Subjects: 28 male and 32 female college students. They formed 33 dyads of the same sex.

Method: Divergent thinking tests: "Plot Titles", "Consequences" and "Alternate Uses". Convergent thinking tests: "Seeing Trends", "Vocabulary Completion" and "Object Synthesis". SCAT scores were also used. The subjects worked, first individually and second as a dyad, on two problems which required the writing of solutions. Three team scores were correlated with both the individual and team abilities. The team scores were: a) total quality (T), a large weight being given to the unusualness of the solutions and a small weight being given to their practicality, b) total number (N), of solutions, and c) average quality, i.e., quality divided by number score. (Two other experiments were conducted with the same general results in this study but only this one included measures of team member abilities.)

Results: The divergent thinking tests provided the best correlations with team performance, particulary the dyad average ability and the higher member ability and especially for the female teams. The significant correlations were as follows:

Divergent thinking score	Males			Females		
	T	N	T/N	T	N	T/N
Higher individual score	.49*			.61**	.45*	.74***
lower individual score						.47*
average team score	.48*	.53*		.56**		.66***

(* ** *** indicate $p < .10, .05, .01$, respectively. T, N, T/N indicate total quality, total quantity, and average quality, respectively.)

Although the relationship between the SCAT scores and team performance were weak, it was of interest that all of the male correlations were negative, while all of the female correlations were positive (except one at -.03).

200. Vernon, J. A., McGill, T. E., Gulick, W. L., and Candland, D. K. Effect of sensory deprivation on some perceptual and motor skills. Perceptual and Motor Skills, 1959, 9, 91-97.

II. B. Tests, Cognitive, Perceptual, Psychomotor, and Memory dimensions

PURSUIT ROTOR, MIRROR DRAWING, RAIL WALKING, DEPTH PERCEPTION AND COLOR PERCEPTION TESTS: DECREMENT WITH SENSORY DEPRIVATION

Tests: (detailed descriptions given in article): Color perception tested with the Dvorine Color Test. Depth perception tested with the Howard-Dohlman apparatus. Pursuit Rotor-time on rotating disc during 60 sec. trial measured. Mirror drawing-time required and errors committed measured. Rail walking-total time to successfully complete entire length without error.

Subjects and method: 18 subjects received the test series three times. Two matched groups of 9 each were formed on the basis of scores received on the first test series. The experimental group was divided into three groups of 3 for the following periods of confinement with sensory deprivation: 24, 48, and 72 hours. The subjects were tested at the end of their confinement and again 24 hours later.

Results: Color perception: a significant difference, at the .05 level, occurred between the experimental and control groups for the 48 and 72 hour confinements. Depth perception: No significant difference between groups. Pursuit rotor: steady improvement for controls; U function for the experimentals with a significant difference ($p < .05$) between the groups for the 48 hour period. Mirror tracing: significant difference only for the 48 hour period for the time measurement. For the error measurement, the significant difference occurred at the 72 hour period. For both measurements, the difference resulted from the failure of the confined group to improve as much as the controls. Rail walking: for both the 48 and 72 hour periods, the controls improved while the experimentals showed a decrement. For the 72 hour period the difference was significant.

RAIL WALKING

Description: Performance was an attempt to get at a more gross motor ability, one which sensory deprived subjects had little opportunity to exercise. It tested the subject's ability to walk upon the narrow edge of a 2"x4" U-shaped rail which was 18' in length. Score was the total time required by subject to successfully negotiate the railing without falling off. If subject fell or stepped off the rail he was required to return to the starting point again. Time recorded was the total time spent by subject on the rail; time required to return to the start after a fall was not counted.

II. B. Tests, Cognitive, Perceptual, Psychomotor, and Memory dimensions

MIRROR DRAWING

Description: A standard concentric six-pointed star is used where the separation between lines was 1/4" and the total length of path to be traced was 22 1/2". Subjects required to trace a path between the pattern lines with a pencil with reference to nothing but the mirror image of the star pattern. Score is the amount of time required to complete the task and the number of errors committed. Error was considered to be any crossing of the lines of the pattern outline.

201. Wade, J. E. Psychomotor performance under conditions of weightlessness. Report No. MRL-TDR-62-73, Aerospace Medical Div., 6570th Aerospace Med. Research Labs., Wright-Patterson AFB, Ohio, June, 1962.

SWITCH PERFORMANCE AND WEIGHTLESSNESS

Task: measured mean response times to operate three different sets of switches; push-button, toggle, and rotary, each paired with a master push-button switch.

Subjects: Volunteers, including five AF officers (2 pilots), four airmen, and 3 civilians (1 woman)

Method: Each subject completed 3 trials under 0 g and 3 trials during normal, level flight. Practice effects were controlled for.

Results: Increase in overall mean response time was 15% during 0-g. The mean response times for the individual switches increased at the rate of: 21% for the toggle, 15% for the push-button, and 9% for the rotary switch. An analysis of variance indicated the subject, switch, and the gravity differences to be significant at $p < .001$ and also the triple interaction to be sig at $p < .001$. The differences between the switches could have been due to either panel arrangement or response compatability.

202. Warren, N., and Clark, B. Blocking in mental and motor tasks during a 65-hour vigil. Journal of Experimental Psychology, 1937, 21, 97-105.

ADDITION AND SUBTRACTION TEST, COLOR NAMING TEST, AND TAPPING TEST:

65 HR SLEEP LOSS STRESS

Test Descriptions:

Addition and Subtraction test: alternate addition and subtraction of 3 from 384 integers which ranged from 4 to 9. Subjects were allowed 3.5 min. to complete the series.

Color Naming test: six colors arranged in random order: red, orange, yellow, blue, green, purple. Total of 140 colors and subjects were permitted one minute to complete the series.

Tapping test: Subject tapped a key on the downward movement and also touched a bar 1.3 inches above the key before beginning another tap. Two trials of one minute each with rest period between.

Subjects: 4 psychology students, one of which completed 48 hours and 3 of which completed the 65 hours without sleep. 4 control students with same test schedule but normal sleep.

Method: Series of tests administered every ten hours.

Results: Block was defined as failure to respond equal in time to 2 or more model responses. Performance on both the Addition and Subtraction test and the Color Naming test was most affected after 40 hours without sleep by the decrease of number of responses and the increase in the percentage of blocks. Performance in both cases was a U function with performance poorer upon conclusion of the vigil than at the beginning. The tapping test was not subject to either the frequency or the increase in blocks as were the mental tests perhaps because the subjects were not required to perform as rapidly as possible. The total number of taps, however, had the same U function with the low point being at 30 hours.

203. Washburne, N. F. A survey of human factors in military performance in extreme cold weather. Washington, D. C.: George Washington University, HumRRO, June, 1960.

ARCTIC COLD STRESSES

Two of the summary statements quoted were: 1) "Work has been done on the effects of cold on motor response and perception. Manual dexterity

is evidently degraded by both general and localized cooling of the body, and reaction time also seems to be slower under cold stress. There is evidence that both visual and aural acuity are affected adversely by large bodies of ice and snow, because of differential reflection patterns to which a man must adjust before he can localize sight and sound cues accurately." (p. 7) 2) "A few studies have been carried on by the Personnel Research Branch of the Adjutant General's Office toward the development of procedures for selection of Army personnel for artic duty. The emphasis has been on stamina, good physical condition, and lack of prior history of cold injury. Psychological factors that seem to be important are stability, maturity, and masculinity." (p. 8)

204. Westrope, M. Relations among Rorschach indices, Manifest Anxiety and performance under stress. Journal of Abnormal and Social Psychology, 1953, 48, 515-523.

DIGIT SYMBOL TEST, TAYLOR MAS, AND RORSCHACH INDICES AS ANXIETY STRESS INDICATORS

Subjects: Students were administered the Taylor MAS. Anxious subjects were those in the upper fifth (12 men, 12 women) while nonanxious subjects were those in the lower fifth (12 men, 12 women).

Method: All subjects subjected to Rorschach administration, 12 practice trials on Digit Symbol test, 3 control trials, and then 3 additional trials on Digit Symbol test under stress conditions. Stress: subject performance observed ostensibly by 3 psychologists and subject shocked just prior to termination of each trial for "substandard" performance.

Results: Stress significantly impaired Digit Symbol performance. Only suggestive evidence that anxious subjects tended to be more affected by the stress. 4 of the 6 Rorschach indices of anxiety differentiated between anxious and nonanxious subjects at an acceptable level. None of the Rorschach intellectual control indices differentiated between the anxious and nonanxious groups. Post-stress self-ratings on an Anxiety-Tension Scale differentiated between anxious and nonanxious at $p < .001$.

II. B. Tests, Cognitive, Perceptual, Psychomotor, and Memory dimensions

205. Weybrew, B. B., and Parker, J. W. Performance effects of increased ambient pressure: I. Helium-oxygen saturation and excursion dive to a simulated depth of 900 feet. Report No. 556, Bureau of Medicine and Surgery, US Naval Submarine Medical Center, Submarine Base, Groton, Conn., November 1, 1968.

EFFECT OF 800 to 900 FT SIMULATED DEPTH ON PERFORMANCE ON FORM BOARD TEST, LETTER CANCELLATION, AND ADDITION TEST

Quoted from abstract:

"Two experienced commercial divers were administered an addition, a letter-cancellation and (the form board) test before, at selected intervals, during, and after a simulated helium-oxygen dive to a saturation depth of 600 feet with excursions to 800 and 900 feet (total dive time 143 hours). Apart from vague joint and muscle sensations...the slow descent to 600' was uneventful. Slightly poorer performance in (the tests) was seen at 800' as were symptoms resembling the so-called helium tremors. No remarkable changes in the test profiles were observed during the implementation of a conservative (15 minutes/foot) decompression schedule, though obscure knee pains in one diver persisted to the "surface" but with no untoward sequelae."

II. C. Tests, Personality and Interaction Dimensions

206. Adorno, T. W., Frenkel-Brunswik, E., Levinson, D. J., and Sanford, R. N. The authoritarian personality. New York: Harper & Row, 1950.

CALIFORNIA F SCALE

Measures: antidemocratic, prejudice, and implicit prefacist tendencies. The variables tested are: conventionalism, authoritarian submission and aggression, anti-intraception (opposition to subjective, imaginative, and tenderminded), superstition and stereotype, power and "toughness", destructiveness and cyncism, projectivity, sex.

Description: Forms 40 and 45 each consist of 30 items of which 26 are the same. Subject indicates degree of agreement with the items. See pp. 255-260 for test items and their arrangement into forms 40 and 45.

Data: Reliabilities: apparently test-retest? A variety of groups were tested, including college students, prisoners, workers and psychiatric patients. The total N= 1518, mean reliability = .90, range was .81 to .97. Data covers administration of form 40, form 45, and forms 40 and 45. Norms: means, standard deviations, and ranges are given for the above groups. Validity: two persons, a high and a low scorer, were intensely interviewed. The authors felt that "The differences between Larry and Mack seem to be reflected fairly well in their F-scale responses."

ETHNOCENTRISM SCALE

Designed to measure prejudice, it was correlated with the F scale scores for several groups:
Form 45: total N=570, r = .73 (average)
Form 40: total N=999, average r = .77

207. Altman, I. and Haythorn, W. W. The ecology of isolated groups. Behavioral Science, 1967, 12, 169-182.

TERRITORIAL BEHAVIOR AND SOCIAL ACTIVITY IN ISOLATION

Subjects: 18 pairs of volunteer sailors who satisfied personality composition criteria (9 experimental dyads, 9 control dyads).

Method: a Greco-Latin square design was used to study dyad compositions (compatible vs. incompatible) of homogeneous high and low and heterogeneous with respect to the following personality characteristics:

Dogmatism (Rokeach Dogmatism Scale), Need Achievement, Need Affiliation and Need Dominance (as measured by the EPPS). The period of isolated confinement was ten days. Indices of territoriality and social activity were obtained through observation.

Results: Territoriality and withdrawal progressed with the passage of time but were significantly affected by the personality composition of the groups. Incompatibility on characteristics associated with interpersonal matters (dominance and affiliation) resulted in high territorality while incompatibility on characteristics relevant to ideas and objects (achievement and dogmatism) did not strongly affect territorial outcomes. For social activities, incompatibility on dominance and dogmatism were associated with high social activity while incompatibility on affiliation and achievement led to social withdrawal.

208. Altman, I. and Haythorn, W. W. The effects of social isolation and group composition on performance. Human Relations, 1967, 20, 313-340.

GROUP COMPOSITION AND PERFORMANCE IN ISOLATION

Method: the same subjects and Greco-Latin square design as was used in reference no. 207. The effects of group composition and Controls vs. Isolateds on performance were evaluated for three tasks. The tasks were: a console monitoring task performed individually, a syllogistic reasoning or decoding task requiring a group decision, and a Combat Information Center (CIC) task which evaluated the group decision in terms of accuracy and use of available information.

Results: in general, the effect of isolation and incompatibility was to significantly enhance performance on the group tasks. The authors interpret this in terms of the beneficial effects of mild stress. The results of a series of Subjective Stress Scales completed by the subjects give support for this contention. Further remarks from this study are given in reference no. 99.

209. Applezweig, M. H., and Moeller, G. Motivation and psychological stress: Final project report, Group Psychol Branch, Office of Naval Research. Project NR 172-228, Contract Nonr 996(02), Dept. of Psychol, Connecticut College, New London, Conn., September 1958. (AD 206834)

II. C. Tests, Personality and Interaction Dimensions

BEHAVIOR INTERPRETATION INVENTORY (BII)

Measures: Motivation. Authors believe that psychological stress is a function of two factors: (1) complexity and flexibility of the behavior repertoire and (2) the motivational pattern existing in the individual at the time. The BII was developed to measure (2). The authors separate motives (long-term generalized behavior tendencies) from modes (short-term or situation-determined types of response) and state that it is necessary to combine a mode analysis with the BII motive profile in order to make predictions in settings in which range of behaviors may be reasonably expected.

Authors define psychological stress as a condition produced by a conflict of motives.

210. Ax, A. F. System and process development for selection of high stress tolerance personnel. NASA Contractor Report 1122, National Aeronautics and Space Administration, Washington, D. C., September 1968.

MOTIVATION MEASURES

Author is conducting research which he hopes will allow current motivation to be measured by physiological responses.

For this report most of the statistics were performed on measures of skin conductance, skin potential, and finger pulse. The subjects included 28 chronic schizophrenic patients and 18 healthy normals. The experiment lasted for 5 days with conditions as follows: first day-3 different tones were presented; second and third days-two of the tones were accompanied by pain; fourth day-only the tones were presented; fifth day-cold pressor test was given. By using different combinations of the response data the author was able to correctly classify from 87% to 96% of the subjects. In summary, the schizophrenic persons do not discriminate between the three tones autonomically.

211. Barratt, E. S. Anxiety and impulsiveness related to psychomotor efficiency. Perceptual Motor Skills, 1959, 9, 191-198.

II. C. Tests, Personality and Interaction Dimensions

BARRATT IMPULSIVENESS SCALE I (BIS)

Description: 45 questions included with 35 filler items. The 45 questions are given in Barratt's article.

Data: test-retest reliability: .87 (one month, N = 300)

Measures: tendencies to take chances, avoidance of tasks requiring patience and detail, to act without thinking.

The research by Barratt indicates that a high score on this test is detrimental to performance on psychomotor activities.

212. Barratt, E. S. Factor analysis of some psychometric measures of impulsiveness and anxiety. Psychological Reports, 1965, 16, 547-554. (Also available as AD 618 803)

MEASURES OF IMPULSIVENESS AND ANXIETY

Subjects: 223 general psychology students; 126 males and 97 females.

Method: Several personality tests were given yielding 30 scores which were factor analyzed. Tests given included: Taylor MAS, Barratt Impulsiveness Scale I, IPAT Anxiety Scale, Otis Intelligence Scale, Barratt Impulsiveness Scale II, GZT, Cattell's 16 Personality Factor Test, Thurstone Temperament Schedule.

Results: This was one of five factor analytic studies which yielded Anxiety and Impulsiveness as independent personality factors. Below are given the scales which had the highest loadings on these two factors:

Test, Scale	Impulsiveness	Anxiety
Taylor Manifest Anxiety Scale		-.78
Barratt Impulsiveness Scale I	.77	
IPAT Anxiety Scale-Cattell Anxiety Covert (A)		-.75
IPAT Anxiety Scale-Cattell Anxiety Covert (B)		-.78
Guilford-Zimmerman Temperament Schedule - Restraint	-.86	
Guilford-Zimmerman Temperament Schedule - Emotional Stability		.84

II. C. Tests, Personality and Interaction Dimensions

Test, Scale	Impulsiveness	Anxiety
Guilford-Zimmerman Temperament Schedule - Objectivity		.77
Cattell 16 Personality Factor - F factor	.69	
Cattell 16 Personality Factor - O factor		-.65
Thrustone Temperament Schedule - Impulsive	.57	
Thrustone Temperament Schedule - Stable		.72

213. Barron, F. An ego-strength scale which predicts response to psychotherapy. In G. S. Welsh and W. G. Dahlstrom, (Eds.) Basic Readings on the MMPI in Psychology and Medicine. Minneapolis, Minn: University of Minnesota Press, 1956. (Also available in J. consult. Psychol., 1953, 17, 327-333)

BARRON'S EGO-STRENGTH SCALE

Description: uses 68 items out of the MMPI. The items, the correct answer, collection of the items into groups, and some mean scores are given in the article. The groups are labeled by the author as follows: physical functioning and physiological stability, psychasthenia and seclusiveness, attitudes towards religion, moral posture, sense of reality, personal adequacy and ability to cope, phobias and infantile anxieties, and miscellaneous.

Measures: "ego-strength" which is seen as characterized by "...physiological stability and good health, a strong sense of reality, feelings of personal adequacy and vitality, permissive morality, lack of ethnic prejudice, emotional outgoingness and spontaneity, and intelligence." (p. 233) Scale was found useful in prediction of patient's response to therapy.

214. Bass, B. M. Social behavior and the Orientation Inventory: a review. Technical Report 9, Contract NONR 624(14). Graduate School of Business, University of Pittsburgh, Pennsylvania, November 1965. (AD 623 691)

II. C. Tests, Personality and Interaction Dimensions

THE ORIENTATION INVENTORY (Ori)

This is a review of research between 1959 and 1965 relating Ori scores to various kinds of other self-reports and to performance in a wide variety of controlled experiments (mean scores are generally given). The author comments "In many such situations, the greatest source of variance may be the interaction of individual orientation and the nature of the task. What is punishing for the self-oriented, may be of no consequence to the interaction-oriented and be positively reinforcing to the task-oriented." (author's abstract) The research surveyed certainly indicates that which subject is the more influential and effective, and what the group interactions will be, seems to be a function of the task, the surrounding environment, and the group composition with respect to orientation.

Definitions of the orientations were given as follows:
Self-orientation: "...a person who is: "...more concerned about his own needs than those of others...more interested in extrinsic reward than intrinsic satisfactions of work...(the group)...is the case as well as the audience before which the self-oriented member can air his personal difficulties, gain in status or esteem, aggress or dominate." (p. 5)

Interaction-orientation: "...a person who consistently is: "...concerned with the group as a means for forming friendships, sharing things with others, providing the security of 'belonging' and helping foster strong interpersonal relationships." (p. 5)

Task-orientation: "...characteristic of persons who in social settings: "...will try...hardest to help obtain the group's goals, solve its problems, overcome barriers preventing the successful completion of the group's tasks, and who persist at...assignments." (p. 5)

Several studies were reviewed which related the Ori scores with self-reported personality and attitude assessments. The self-oriented person appeared as one who tends to be competitive, irritable, and inflexible. The interaction-oriented person tends to express affiliation needs and to be sociable. The task-oriented person tends to be persistent, liberal and high in endurance.

II. C. Tests, Personality and Interaction Dimensions

215. Beer, M., Buckhout, R., Horowitz, M. W., and Levy, S. Some perceived properties of the difference between leaders and non-leaders. Journal of Psychology, 1959, 47, 49-56.

LEADERSHIP RATING SCALE

Cost: group admin., 1 form which can be copied from Journal article, 26 items in test.

Data: 10 groups of college students (5 male, 5 female) consisting of 1 elected leader and 10 members were administered the scale. The results of the t-test for leader, non-leader score differences: 6 items were significant at $p < .01$, 8 items at $p < .05$.

Description: 26 test items which are rated on a scale between positive and negative by a check mark.

Measures: Authors define leaders as those who have been elected to leadership positions and attempt to measure three components of leadership: self acceptance, need achievement, interpersonal skills.

216. Berkowitz, L. Studies in group norms: the perception of group attitudes as related to criteria of group effectiveness. AFPTRC-TR-54-62 res bull. Project no. 7713, task no. 77220, AF Personnel and Training Res. Center, Lackland AF Base, San Antonio, Texas, February 1954. (AD 62107)

SCALES MEASURING MOTIVATION TO HAVE AN EFFECTIVE CREW AND CREW PERSONAL LIKING ATTITUDE

Reliability: Corrected split-half for N = 100 for motivation scale is .76 (however, only 2 test items actually used). Corrected split-half for N = 100 for attitude scale is .82

Subjects: Analysis based on 46 to 159 B-29 crews consisting of from 8 to 11 men. Data taken both during early and late training.

Description: Short paper and pencil test which yielded 2 attitude scales and a measure of the extent to which crew members perceive each other as being motivated to have a good crew. Test content and scoring procedures given in article. Fourteen effectiveness criterion measures were taken.

Results: Early training data: Only 4 criterion measures correlated significantly with the test results: as follws: the greater the number of crew members perceived as having high motivation, (1) the lower the average crew mission grade at $p<.01$, (2) the greater the number of absentees from scheduled military formations at $p<.10$, (3) the greater the number of sick calls on the day before or on the scheduled flying day at $p<.10$, (4) the greater the number of sick calls in crews not assigned flying duty at p .10. Late training data: only 3 criterion measures correlated significantly: with the greater the number of crew members seen as being highly motivated: (1) the higher the average crew mission grade ($p<.05$), (2) the higher the average instructor rating of the crew at $p<.05$, and (3) the smaller the number of absentees from scheduled formations at $p<.10$.

Comment: As authors state, "...results are pregnant with hypotheses but, unfortunately, offer relatively little closure."

217. Berkun, M. M., Bialek, H. M., Kern, R. P., and Yagi, K. Experimental studies of psychological stress in man. Psychological Monographs, 1962, 76, No. 15 (Whole No. 534).

SSS VALIDITY (SUBJECTIVE STRESS SCALE)

Series of experiments were run in which the authors tried to make the experiment appear to be a real-life emergency situation. The SSS and most of the physiological measures differentiated between the control and experimental subjects in every situation.

Situation	N of exp. Ss	N of control Ss	P
Airplane ditching	15	20 & 26	.05, .01 (total)
3 individual situations with immediate danger	13, 26 & 24	17	.10, .05, .05
Demolitions accident	27	20 & 23	.01, .001 (total)

A revised version of the SSS is given in the article.

II. C. Tests, Personality and Interaction Dimensions

218. Birney, R. C., Burdick, H. and Teevan, R. Projective studies of fear of failure. Contract No. Nonr 2309 (02), Group Psychology Branch, Office of Naval Research. Department of Psychology, Amherst College, November 1960. (AD 250 517)

HOSTILE PRESS SYSTEM FOR THE TAT

Measures: fear of failure, a measure of level of aspiration. Elaborates Murray's Press system.

Description: Stories are written for TAT cards. The scoring procedures and examples are presented in the article. The scoring procedures are based on the distinction between themas wherein the persons react as contrasted with those who energize. "The Hostile Press themas are those in which the central figures strive to escape, adjust, or overcome. There is no sense that these figures are trying to accomplish something of their own, to express themselves, or to get somewhere." (p. 14)

Some of the developmental studies on level of aspiration are given.

219. Birney, R. C., Birdick, H. and Teevan, R. C. Fear of failure and the achievement situation. Tech Report No. 1, Group Psychology Branch, Office of Naval Research Contract Nonr 3591(01), NR 171-803 with Bucknell University, 1964. (AD 430 406)

HOSTILE PRESS SYSTEM, NEED TO ACHIEVE AND NEED TO AFFILIATE AS MEASURED BY THE TAT

This document discusses the earlier experiments covered in the author's 1960 document and some later research on these measures. The basis for scoring stories for Hostile Press thema is presented.

220. Borg, W. R. Prediction of small group role behavior from personality variables. Journal of Abnormal Social Psychology, 1960, 60, 113-116.

ASSERTIVENESS, POWER ORIENTATION, RIGIDITY, AND AGGRESSIVE NONCONFORMITY BATTERIES

Method: 819 Air Force officers were assigned to groups of 12-14 members each to work on and solve practical Air Force problems using seminar group discussion. Peer nominations for various roles occurred during the second and fifth weeks of group activity. Factor analysis was applied to the test measurement set.

II. C. Tests, Personality and Interaction Dimensions

Tests administered: 7 items selected from the FIRO test; Calif. F scale, Form 40; Anxiety to Achieve Battery consisting of 6 group tests from the Cattell Objective Analytic Personality Battery; Social Extroversion Score from the Inventory of Factors STDCR (Guilford); Eight Factor Scores from the Guilford Opinion Inventory. Yielded total of 18 scores.

Results: Four factors emerged from the factor analysis of which one, Assertiveness, correlated well with peer group nominations with respect to role descriptions. The Factor Assertiveness correlated with the peer group nominations as follows:

.245	Popular-social
-.221	Good follower
.422	Assertive
.216	Rigid
.423	Creative
.389	Leader

The other factors which emerged from the analysis were: Power orientation, Rigidity, and Aggressive Nonconformity. The test items and factor loadings are given for the Assertiveness measure. The complete data and role descriptions can be obtained from: American Documentation Institute, Document No. 6094, Photoduplication Service, Library of Congress, Washington 25, D.C.

221. Borgatta, E. F. A systematic study of interaction process scores, peer & self-assessments, personality and other variables. Genetic Psycholoical Monographs, 1962, 65, 219-291.

ACTIVITY, ASSERTIVENESS

Personality inventories have first order correlations that indicate significant relationships to activity or assertiveness which are minimized in factor analysis.

222. Borgatta, E. F. A very short test of personality: the Behavioral Self-Rating (BSR) Form. Psychological Reports, 1964, 14, 275-284. (Also available as AD 438 390)

BEHAVIORAL SELF-RATING (BSR) FORM

Test: Paper and pencil test containing 20 items (a subset of the 34-item Borgatta Group-Personality Test) on which the subjects were required to rate themselves and which fell consistently within one of the five clusters: Assertiveness, Sociability, Emotionality, IQ and Responsibility. The items are given in the article.

Subjects: data based on two sources: (1) included in a survey questionnaire, 770 completed forms, (2) administered to 305 male and 311 female college students.

Data: Norms are presented based on the survey and college populations, broken down by male and female categories. Intercorrelation matrices for each of the populations are given.

223. Borgatta, E. F. The structure of personality characteristics. Behavioral Science, 1964, 9, 8-17. (AD 438 391)

BORGATTA'S GROUP-PERSONALITY TEST: PERSONALITY CHARACTERISTICS RELATED TO SMALL GROUP INTERACTION

Test: Paper-and-pencil test containing 34 items on which the subjects were required to rate themselves, rank themselves, and to rank their peers. Each of five factors had four items with relatively high factor loadings under all conditions. The five factors were: Assertiveness, Likeability or Sociability, Emotionality, Intelligence, and Task Interest or Responsibility. All of the test items and procedures are given in the article.

Subjects: 335 college girls from sororities and 144 college males in fraternities.

Method: Subjects were ordered into 5-person units by their sorority or fraternity presidents in two ways: first according to a criterion of members knowing each other well and usually associating with one another, and second, according to the criterion of the members knowing each other as little as possible and at different class levels. The subjects were required to rank themselves and the members of each group and, in addition, to rate themselves on a scale of from 0 to 9 on the same items as a part of a questionnaire. There was then a "multimethod-multitrait matirx: intimate group peer-and self-ratings, stratified group peer- and self-ratings, male and female, and self-ratings. Factor analysis was performed on the data under each condition and the five above-mentioned factors held up fairly consistently.

II. C. Tests, Personality and Interaction Dimensions

224. Buros, O. K. (Ed.) The Fourth Mental Measurements Yearbook. Highland Park, N. J.: Gryphon Press, 1953.

CALIFORNIA TEST OF PERSONALITY

Data: The split-half reliability on the first edition ranged from .6 to .9. Norms are available.

THE GUILFORD-ZIMMERMAN TEMPERAMENT SURVEY

Data: Validity based on factor analysis. Generally small intercorrelations; two are high at .40 and .61.

THURSTON TEMPERAMENT SCHEDULE

Ages: Grades 9-16 and adults.

Data: Norms available.
Split-half reliabilities range from .45 to .86.
Retest reliabilities on one group ranged from .61 to .82.
Scores are result of factor analysis; most are statistically independent but two are above .50.
Only validities given are correlations with other temperament scales.

Description: 140 questions from which seven scores are obtained.

Measures: The seven scores are: active, vigorous, impulsive, dominant, stable, sociable, reflective.

225. Buros, O. K. (Ed.) The Fifth Mental Measurements Yearbook. Highland Park; N. J.: Gryphon Press, 1959.

OBJECTIVE-ANALYTIC PERSONALITY TEST BATTERY

Ages: 11-16, and adult

Cost: $3 per tape recording, $5 per manual. Several batteries are available. Group or individual administration. Some of the subtests require additional equipment.

Data: no data on reliability and no norms. Validity tests on factor analysis but the reviewer commented that the factor loadings should not be considered generally reliable because of the limitations of the data on which they're based.

Description: The tests are based on Cattell's factor analytic studies. Tests are available for 18 factors. A large variety of tests are given, including tests of flicker fusion, body sway suggestibility, color-form sorting, estimation of time passage, etc.

226. Buros, O. K. (Ed.) The Sixth Mental Measurements Yearbook. Highland Park, N. J.: Gryphon Press, 1965.

CALIFORNIA PSYCHOLOGICAL INVENTORY (CPI)

Ages: 13 and older

Cost: $6.25 per 25 tests; $3.75 per 50 sets of profiles and answer sheets; $4.50 per set of hand scorings pencils; $6 per set of IBM scoring stencils; $3.25 per 50 NCS answer sheets; 75¢ per administrator's guide; $3 per manual; $1 per specimen set. 45-60 minutes; group administration.

Data: Norms are available.
Reliability: one year test-retest (on high school students) median correlation for males was .65 and for females was .68.
Validity: 11 of the 18 scales are based on empirically derived scoring weights and all of the scales have been cross validated.
Factor analysis indicates that the 18 scales would probably give the same information if reduced to 4 or 5 scales.

Measures: 18 scores include: dominance (Do), capacity for status (Ca), Sociability (Sy), social presence (Sp), self-acceptance (Sa), sense of well-being (Wb), responsibility (Re), Socialization (So), self-control (Sc), tolerance (To), good impression (Gi), communality (Cm), achievement via conformance (Ac), achievement via independence (Ai), intellectual efficiency (Ie), psychological-mindedness (Py), flexibility (Fx), Femininity (Fe).

Description: 480 items; the median contribution per score is 37 items.

II. C. Tests, Personality and Interaction Dimensions

CALIFORNIA TEST OF PERSONALITY, 1953 Revision

Ages: 5 levels ranging from kindergarten to adult.

Cost: $3.50 per 35 tests; 5¢ per IBM answer sheet, 9¢ per Scoreze answer, 20¢ per hand scoring stencil, 75¢ per machine scoring stencil; 50¢ per specimen set of any one level. Group administration, 45 to 60 minutes.

Description: 16 scores: self-reliance, sense of personal worth, sense of personal freedom, feeling of belonging, withdrawing tendencies, nervous symptoms, total personal worth, social standards, social skills, anti-social tendencies, family relations, school relations, occupation relations, community relations, total social adjustment, total adjustment.

EDWARDS PERSONAL PERFORMANCE SCHEDULE

Cost: Group administration; 40-55 minutes. 50¢ per 25 tests; $2.50 per 50 hand scoring answer sheet; $2.40 per 50 IBM answer sheets; $3.25 per 50 NCS answer sheets. Set of manual and keys: 60¢ with hand scoring template, $1.50 with set of hand scoring stencils for IBM answer sheets, $1.65 with set of machine scoring stencils. 75¢ per specimen set.

Data: College and adult norms on males and females.
Internal consistency reliability median is .78.
One week test-retest reliability median is .83.
Three week test-retest reliability median is .73.
"Validity data in the manual are meagre." (p. 195)

Description: test includes 210 items to test 15 manifest needs selected from Murray's need system. Each need is represented by nine statements.

Measures: 15 scores are obtained: achievement, deference, order, exhibition, autonomy, affiliation, intraception, succorance, dominance, abasement, nurturance, change, endurance, heterosexuality, aggression. The reviewers seem to concur that, "...a decade of research into the validity of the EPPS offers little justification for assuming that its scales measure the constructs that they are intended to reflect, or that, with the important exception of the link between the Achievement Scale and academic achievement, the scales are useful in predicting socially important variables." (p. 206)

II. C. Tests, Personality and Interaction Dimensions

EYSENCK PERSONALITY INVENTORY

Age: high school, college and adults.

Cost: $3/25 tests; $1.50 per set of scoring pencils; 50¢ per manual; $1.75 per specimen set; 15-20 minutes administration time.

Data: British norms only; no reliability data or norms on the lie scale.

Description: 3 scores are obtained: extraversion, neuroticism, and lie. This is considered to be a revision of the Maudsley Personality Inventory, but the author recommends that both the EPI and MPI be used or only the MPI, since far more data is available on it. The advantages of the EPI are given as (1) the presence of two parallel forms and (2) the addition of nine items from the lie scale of the MMPI, and (3) better selection of items to minimize the correlation between the E and N scales.

FIRO-B (FUNDAMENTAL INTERPERSONAL RELATIONS ORIENTATION-BEHAVIOR)

Age: high school and adults

Cost: group, 8-15 minutes, 1 form (2pgs), 8¢ per test, $1/scoring template,
$6.50 per text (book by Schutz which includes technical data)

Data: hectographed norms, adults only

Description: 6 scores: expressed inclusion, wanted inclusion, expressed control, wanted control, expressed affection, wanted affection. Nine items per score, i.e., 54 items total.

GROUP DIMENSIONS QUESTIONNAIRE

Cost: $3.50/25 tests; $2/25 IBM answer sheets; $2.50/manual; 45-60 minutes group administration.

THE GUILFORD-ZIMMERMAN TEMPERAMENT SURVEY

Age: grades 12-16 and adults

Cost: group, 50 minutes, IBM, 1 form (8pgs), $4/25 tests, 25¢/single copy, 5¢/IBM answer sheet, $2.50/set of either hand or machine scoring stencils, 4¢/profile, 35¢/manual, $4.25/set of scoring stencils and manual for falsification scales, 4¢ per copy of temperament map

Data: norms available based on college population (900) and high school seniors and parents
Reliability: .75 to .85, various methods

Description: 10 scores: general activity, restraint, ascendence, sociability, emotional stability, objectivity, friendliness, thoughtfulness, personal relations, and masculinity.

The IPAT Anxiety Scale Questionnaire (also called IPAT ANXIETY SCALE)

Ages: 14 and over

Cost: 1 form and manual; $3 per 25 tests; 50¢ per scoring key; $1.80 per manual; $2.40 per specimen set; 5 to 10 minutes; group administration.

Data: Norms available based on age and sex.
Reliabilities for the total score range from .80 to .93.
(Component reliabilities range from .26 to .60).
Construct validities given as .85 to .90.
As a differentiator between neurotics and normals, validity is .65.

Description: 40 items from which scores can be derived: self sentiment development, ego strength, protension of paranoid trend, guilt proneness, ergic tension, total anxiety, covert anxiety and overt anxiety.

Measures: assesses the general free anxiety level.

LEADERSHIP OPINION QUESTIONNAIRE

Cost: 1 form (4 pgs), 2 scores, $4.95/20 tests, 35¢ per manual, 60¢ per specimen set, 15-20 minute group administration.

MAUDSLEY PERSONALITY INVENTORY (MPI)

Age: College and adults.

Cost: $3 per 25 tests; $1 per set of test booklet hand scoring stencils; $5 per 100 IBM port-a-punch cards; $1.25 per manual; $1.75 per specimen set. Group administration; 10-15 minutes.

Description: two scores: extraversion and neuroticism. Test consists of 48 items, 24 for each scale.

Data: norms are available.
reliability: split-half and Kuder-Richardson estimates of item intercorrelations for each scale range between .75 and .90. Test-retest reliabilities range from .70 to .90.
validity: scales are the result of factor analytic studies; their usual correlation is -.15. "Descriptive validity of the MPI has been adequately established by the method of nominated groups."

Measures: Neuroticism, described as general emotional instability, emotional overresponsiveness and predisposition to neurotic breakdown under stress. Extraversion, described as outgoing, uninhibited, impulsive, and sociable.

MMPI, REVISED ED

Cost: Editions for individual or group administration; 30 to 90 minutes. $1.50/manual. Individual Form ("The Card Set"): 550 cards plus sorting guides and record blank; $25.50 per set of testing materials including 50 record blanks, $3.75/50 record blanks; $8.50/ set of manual and scoring stencils. Group form ("The Booklet Form"): IBM, NCS, and Hankes; test, profile, separate answer sheets; $5.50 per 25 tests, $4/50 sets IBM answer sheets and profiles, $2/50 Hankes answer sheets, $3.25/50 NCS answer sheets, $4.50/set of manual and hand scoring stencils, 65¢/set of manual and machine scoring stencils; $1.75/specimen set with no scoring stencils.

Description: Ages 16 and over. Fourteen scores: hypochondriasis (Hs), depression (D), hysteria (Hy), psychopathic deviate (Pd), masculinity and femininity (Mf), paranoia (Pa), psychasthenia (Pt), schizophrenia (Sc), hypomania (Ma), social (Si), question (?), lie (L), validity (F), test taking attitude (K).

Measures (ex reviewer comments): "The MMPI...does not pretend to provide basic personality dimensions but to predict the currently accepted psychiatric categories...They have empirical validity in that they are

the basis of actual treatment...it was not designed...as a useful test for a general survey of personality." Analysis of the scale scores in 3 studies resulted in agreement among the three on two 2nd-order factors, ego strength and extroversion. However, ego strength is not agreed upon in that one author calls it emotionality, another calls it anxiety and the third calls it ego strength.

Comments by a second reviewer: MMPI differentiates well between those who do and do not have emotional and adjustmental problems. However, for assessing personality within the normal range of adjustment, it is not adequate.

THE ORIENTATION INVENTORY

Ages: college and industry

Cost: $3 per 25 tests; $1 per set of manual and key; $1 per specimen set. Group administration; 20-25 minutes.

Data: Norms on 908 college students available.
Test-retest reliability ranges between .73 and .76 for the three scales.
Concurrent validity indicated by tendency for task-oriented supervisors to be more successful than self-oriented supervisors.
Data indicates that Self-Orientation score is probably independent of the other two, but that the Task- and Interaction-Orientation are bipolar orientations.

Description: test consists of 27 items, each with three alternatives which represent the three possible alternatives which the test measures: self-, task, and interaction-orientation. The subject chooses one of the alternatives as the most preferred answer and one as the least preferred.

SIXTEEN PERSONALITY FACTOR QUESTIONNAIRE

Age: 15-16, plus

Cost: Forms A & B: Group, 50-60 min. for A or B, NCS Forms, 10 pgs each with separate answer sheets, $12.50/25 tests A or B, $4.50/50 hand scored answer sheets, $3.25/50 machine score answer sheets for A & B combined, $5.40/50 combined answer sheet-profiles, $2/set of keys for A or B, $3.80/50 separate profiles, $2.90/manual, $5/specimen set of A & B. Form C: $.0/25 tests, $1/key, $1.20/supplementary manual, $4/specimen set, $2.40/abbreviated specimen set (incl. only supplementary manual), $38/examiners kit of tape edition. 30-40 minutes. Group short form.

II. C. Tests, Personality and Interaction Dimensions

Data: Norms available only on age basis of age and sex
Reliability: .93 to .71 for A & B both, 187 to .54 for single form (based on earlier test edition). No data on 1961-62 edition.
Validity: 6 factors are supposed to be primary factors. However, other studies indicate: (1) only 8 factors and (2) nearly 25% of intrafactor correlations were in the wrong direction and 30% were insignificant.

Description: Motivational distortion scale measured by form C only, which is a simplified short form of 105 items. Forms A & B each have 187 items or 10 to 13 items per factor.

CATTELL'S FACTORS are listed as being:
(A) less intelligent vs. more intelligent
(B) affected by feelings vs. emotionally stable
(C) humble vs. assertive
(E) sober vs. happy go lucky
(F) expedient vs. conscientious
(G) shy vs. venturesome
(H) tough- vs. tender-minded
(I) trusting vs. suspicious
(L) practical vs. imaginative
(M) forthright vs. shrewd
(N) placid vs. apprehensive
(O) conservative vs. experimenting
(Q1) group dependent vs. self sufficient
(Q2) casual vs. controlled
(Q3) relaxed vs. tense
(Q4) motivational distortion scale (form C only)

NOTE: these are not, however, the same as given in reference No. 227.

THEMATIC APPERCEPTION TEST (TAT)

Ages: 4 and older

Cost: individual administration over two days, 120 minutes per day. $6 per set of testing materials; 50¢ per manual; $1.25 per 10 blanks; $1.75 per 100 analysis sheets; 35¢ per manual; 60¢ per specimen set of 1 blank, 10 analysis sheets, and manual.

Data: estimates of scoring reliability range from .54 to .91. Average internal consistency is .13.

Description: a projective test where the subject gives a story in response to a picture.

Measures: the TAT is an indicator of general interests, important current sources of motivation, areas of emotional disturbance, and clues of clinical discussion. Not considered by reviewer to be suitable for providing a profile of personality traits or giving a reliable measurement of any particular trait.

THURSTONE TEMPERAMENT SCHEDULE

Cost: $10.80 per 20 tests; $1.15 per specimen set; 15-20 minute group administration. Hand scored edition: $2.40 per 20 answer sheets. Machine scorable edition: $5 per 100 IBM answer sheets; $2.50 per set of scoring pencils.

227. Cattell, R. B., and Stice, G. F. The Psychodynamics of small groups. Final report on Research Project NR 172-369, Contract N80nr-79600, Human Relations Branch, Office of Naval Research, Urbana, Illinois: Laboratory of Personality Assessment and Group Behavior, University of Illinois, 1953. (AD 8002)

SIXTEEN P F TEST AND GROUP DIMENSIONS

Subjects: young men drawn from University of Illinois, Officer Candidate School and the Naval Training Center. Of 100 groups of 10 members each, the majority of the statistics used the data from 80 groups due to absenteeism.

Method: Each group met 3 times, each time for about 3 hours. The measures taken were as follows:

(1) Individual population measurements including 16 personality factors (Sixteen PF test), 1 attitude and 1 interest factor; these resulted in 32 variables.
(2) 25 sociometric scores
(3) 15 rating scores on group structure
(4) 20 rating scores on group interaction
(5) 12 group tasks ranging from construction, decision, problem-solving, to discussion. Statistical (multiple analysis: simple structure) analysis was performed on the intercorrelations of the group syntality variables, the social structure variables and the population variables in a single pool. This was done three times, once for each session.

II. C. Tests, Personality and Interaction Dimensions

Results: group dimensions: 14 to 16 factors were found in each of the three sessions and 13 of these factor patterns are stably recognizable in 2 or more sessions. Six are matchable through 3 sessions, four at a high level of confidence. The 13 dimensions are a result of personality factors (population means), heterogeneity with respect to single personality factors, certain combinations of personality factors, and accidents of early group history and circumstances. The 13 dimensions in descending order of stability and clarity are:

1. High synergy through leadership vs. disintegrative low morale; primarily interest in the group's existence and purpose.
2. High immediate synergy through personalities vs. low intrinsic synergy; quicker group growth which is related to low mean paranoid and higher mean IQ and maturity.
3. Adventurous forcefulness of population vs. individual insight; related to high mean population loadings on personality factors H, F, G and E
4. Plodding, fortitudinous morale vs. irresponsible verbality; slow performance with plodding planning and high morale in difficult situations.
5. Intellecturally effective cyclothyme role interaction vs. low morale I; high cyclothymia and dominance, low paranoid and some high intelligence with high accuracy of group judgment, high lability and emotional suggestibility, and general excellence on group intellectual activities, especially those of unspoken coordination.
6. Sophisticated democratic determination vs. lack of group self possession. High score on the personality factor of sophistication and some positive score on paranoia, goes with low suggestibility, determined behavior, good morale and motivation.
7. Frustration through temperamental heterogeneity. High varience on personality factors N, M, L, and I and high mean on M associated with internal dislike, need for leadership techniques, and rigidity of individual attitudes.
8. Divided into 3 factors: Frustration of group through high dominance, surgent democratic communicativeness, and unsophisticated suggestible palaver.
9. Garrulous nervous emotionality vs. morale of effort
10. Indifference or low group synergy vs. high reward morale
11. Slow, rigid, unintegrated deliberation with frustration
12. Low organization vs. sense of purpose
13. Unanimity on the leader

II. C. Tests, Personality and Interaction Dimensions

Performance reliabilities on group tasks: ranged from .08 to .55 with a mean of .27.

THE SIXTEEN PERSONALITY FACTOR QUESTIONNAIRE FACTORS ARE GIVEN AS:

A. Friendly cyclothymia vs. Taciturn, schizothymia
B. Level of general ability (Intelligence)
C. Emotional maturity or ego strength vs. general neuroticism
E. Dominance
F. Sugency (spontaneous fluency of ideation & impulsiveness) vs. Desurgency
G. Character integration or super ego strength
H. Adventurous Cyclothymia vs. self-conscious, withdrawn schizothymia
I. Tenderminded sensitivity vs. hard-headed practicality
L. Paranoid suspiciousness vs. lack of this
M. Bohemian hysteric aggressiveness vs. practical concernedness
N. Polished fastidiousness vs. rough simplicity
O. (-) Absence of worrying anxiousness (free anxiety)--Worrying suspicious anxiety vs. calm trustfulness
Q1. Radicalism vs. Conservatism
Q2. Independent self-sufficiency vs. lack of resolution
Q3. Deliberate will control vs. lack of independence
Q4. (-) Absence of nervous tension (somatic anxiety)

NOTE: these are not the same, however, as given by reference No. 226.

228. Cattell, R. B. and Stice, G. F. Four formulae for selecting leaders on the basis of personality. Human Relations, 1954, 7, 493-507.

LEADERSHIP PREDICTION FROM THE SIXTEEN PERSONALITY FACTOR QUESTIONNAIRE

Subjects: 34 groups comprised of 334 strangers. 14 groups were new arrivals to AF Officer Candidate School; 20 groups were new arrivals for AF Boot Training. 18-30 years old. Motivated by offer of $100 to best of 10 groups.

Method: Group tasks: committee decisions, constructions, tug-of-war, crytogram solving. Four types of leaders were defined: (1) problem solving, (2) salient, (3) sociometric, and (4) elected. Types 1 and 2 were rated by observers. Type 3 was rated sociometrically during the third (the last) group meeting. Elections were held five times during the three meeting time span. The subjects were administered the 16 PF Questionnaire.

A5

II. C. Tests, Personality and Interaction Dimensions

Results: The factors from the 16 PF which best differentiated between leaders and members:
factor G $p<.01, <.01$ (i.e., significantly differentiated two types of leaders from the members)
factor O $p<.05, <.05, <.01$
factor H $p<.01, <.01, <.01$
factor Q_3 $p<.01, <.05, <.05, <.05$

Other factors differentiated between the four types of leaders:

type 1 from types 2, 3 & 4: factor B, $p<.05, <.01, <.01$
type 4 from types 1, 2 & 3: factor F, $p<.01, <.01, <.01$
type 1 from types 2, 3 & 4: factor F, $p<.01, <.01, <.01$
type 2 & 3 from types 1 & 4: factor Q_2: $p<.05, <.01, <.01, <.01$

229. Cattell, R. B., and Warburton, F. W. Objective personality and motivation tests. Urbana, Illinois: University of Illinois Press, 1967.

PERSONALITY TESTS

Presents a detailed discussion on the author's approach to the construction, use and classification of personality tests. Primarily oriented towards the 21 personality factors which have resulted from the experimental research with which he has been concerned:

U.I.16 Narcissistic ego vs. Unassertiveness
U.I.17 Timid distrust vs. Trustingness
U.I.18 Smartness vs. Passiveness
U.I.19 Independence vs. Subduedness
U.I.20 Comention vs. Objectivity
U.I.21 Exuberance vs. Suppressibility
U.I.22 Cortertta vs. Pathemia
U.I.23 Mobilization vs. Regression
U.I.24 Anxiety vs. Adjustment
U.I.25 Realism vs. Tensinflexia
U.I.26 Self-realization vs. Homespunness
U.I.27 Unmovedness vs. Involvement
U.I.28 Super ego asthenia vs. Rough assurance
U.I.29 Determined responsiveness vs. Lack of will
U.I.30 Mature stolidness vs. Dissofrustance
U.I.31 Wary steadiness vs. Impulsive Variability
U.I.32 Exvia vs. Invia
U.I.33 Reactive dismay vs. Sanguine poise
U.I.34 Inconautia vs. Practicalness
U.I.35 Stolparsomnia vs. Excitation
U.I.36 Strong self-sentiment vs. Weak self-sentiment

II. C. Tests, Personality and Interaction Dimensions

The compendium consists of the description of 421 tests, each with a set of possible measures specified, which are indexed in a number of ways: test titles are indexed with respect to a test number, a master index number, and alphabetical order, and are grouped with respect to the manifest content and according to the above personality factors. A bibliography covering researches in which the tests have been used is given.

230. Christie, R. Authoritarianism re-examined. In R. Christie and M. Jahoda, (Eds.) Studies in the scope and method of "The Authoritarian Personality." Glencoe, Illinois: Free Press, 1954.

CALIFORNIA F SCALE

A summary statement by the author concerning his research review: "Turning to the empirical correlates of the F scale it was concluded that it did discriminate between individuals who displayed behavior which was authoritarian in interpersonal relations rather than politically. Individuals high on the F scale tended to be condescending toward inferiors, resistant to scientific investigation, more sensitive to superiors than peers, and more prone to project their own attitudes upon others. Although these differences are consistent, they are not characterized by an exceptionally high degree of discrimination between individuals high and low on the F scale."

231. Cleven, W. A. and Fiedler, F. E. The relations of open hearth foreman's interpersonal perceptions to steel production. Technical Report No. 11, Contract N6 ORI 07135, Urbana, Illinois, University of Illinois, Dept. of Psychology, October 1955.

ASO and STEEL PRODUCTION

Procedure: Steel worker hearth foremen responded to the Assumed Similarity test as they felt the man with whom they worked best would respond and as the man with whom they worked least effectively would. The ASO measure was related to an on-the-job measure of performance based on work output.

Results: In general, supervisors of more effective shops differentiated significantly more between their best and worse co-workers then did supervisors of less effective shops. A separate analysis of four types of supervisors showed this to be a tendency among pit foremen and senior melters but not among general foremen and stock foremen.

232. Comrey, A. L. Group performance in a manual dexterity task. Journal of Applied Psychology, 1953, 37, 207-210.

PURDUE PEGBOARD

Less than 50% of group (pairs) performance on the Purdue Pegboard was predicted from the individual performance. 65 pairs were used.

233. Comrey, A. L. and Deskin, G. Further results on group manual dexterity in men. Journal of Applied Psychology, 1954, 38, 116-118.

PURDUE PEGBOARD

Predictibility of group (pairs) performance from individual performance on Purdue Pegboard was not significantly improved by making individual performance duplicate the manipulations required of the individual in the group performance.

234. Comrey, A. L. and Staats, C. K. Group performance in a cognitive task. Journal of Applied Psychology, 1955, 39, 354-356.

CROSSWORD PUZZLE

82% of group performance (pairs) (R=.91) on a crossword puzzle was predicted by the individual performance on a crossword puzzle. Scores from the GZTS did not correlate with group performance. 60 pairs were used.

II. C. Tests, Personality and Interaction Dimensions

Author suggests that the degree of cooperation required in a task is a criterion for the type of predictive test; i.e., Purdue Pegboard task required cooperation while the crossword puzzle task did not.

235. Coburn, K. R. The effects of stress produced by confinement in small groups. In Part II of: A Report of the Physiological, Psychological, and Bacteriological Aspects of 20 Days in Full Pressure Suits, 20 days at 27,000 feet on 100% Oxygen, and 34 Days of Confinement. NASA CR-708, US Naval Air Engineering Center, Philadelphia, Pennsylvania, February 1967.

MOTIVATION, TIME ESTIMATION, GRP COHESIVENESS, AND VERBAL LEARNING & AFFECTIVE CHANGE DURING CONFINEMENT

Method: This was one of a series of studies carried out on eight subjects during a 34 day confinement. The subjects were volunteer outstanding USN and USMC aviators who had volunteered for astronautics. The tests and variables measured are as follows:
Verbal learning and affective change - paired associates, i.e., nonsense syllables paired with either potentially affective or neutral words.
Group cohesiveness - modified version of Fiedler's ASo test.
Motivation - force exerted on a hand dynamometer with no grip displacement.
Time estimation - estimation of four intervals; 15, 90, 180, and 300 seconds. A complete description of the tests and words used is given in the article.
Results - Paired associates: no stress was reflected in the data except that a few words did acquire some affect during the confinement. Cohesiveness: no significant changes occurred. Dynamometer: the expected force increase did occur and task seemed to measure intra-experimental motivation. Time estimation: no overestimation increase and no significant correlation with manifest anxiety occurred.

The author felt that an important result was the significant correlations (positive) between the Dynamometer and Group Cohesiveness and between the Dynamometer and Daily Questionnaire (negative) reports of irratibility for the days 7 through 28; sig at $p < .02$ and $p < .04$ respectively. The importance rests with the apparent sensitivity of the Dynamometer measurement since the performance of the subjects on other tasks during this period showed no significant decrement.

236. Cramer, E. H. and Flinn, D. E. Psychiatric aspects of the SAM Two-Man Space Cabin Simulator. SAM-TDR-63-27, AFSC Task 775504, WSAF School of Aerospace Medicine, Brooks AF Base, Texas, September 1963. (N63 23338)

DEPENDENCY, INTERPERSONAL RELATIONS, ETC. ON 17- AND 30-DAY CONFINEMENTS IN SPACE CABIN

Subjects: 6 rated pilots.

Method: Confinements included two 30-day flights at 18000 ft, four 17-day flights at 33,500 ft, and two 17-day control flights at ground level. Primary purpose was the study of life support, logistics and metabolic characteristics. Behavior and subject interaction studied through pre- and post-flight psychiatric and psychologic evaluations, and by means of TV observation and subject diaries.

Results: One personality factor which caused some difficulties, both task- and inter-personal-related, was the relative inability on the part of some subjects to accept dependent role when necessary. The effect of stresses and the author's evaluation are as follows: confinement- expected subjective reactions did not materialize other than desire for exercise. Perceptual distortions-occurred at least once for nearly half of subjects but were transient; lack of seriousness was felt to be due to presence of second person. Monotony-seemed to be the most serious stress; authors suggest capacity to fantasy comfortably would be desirable. Sleep-opportunities for sliip occured in 2- and 3-hour blocks with one 5-hour block every other day. Ability to adjust to this schedule and the consequent strains varied greatly. Dirrnal cycle - considerable disorientation occurred. Needs - tension and sanitation were stressful. Sexual needs were apparently not a big problem. Interpersonal relations - tension and irritation was a definite problem on 6 of the 8 flights where personality characteristics and habits clashed.

237. Cronbach, L. J., Hartmann, W., and Ehart, M. E. Investigation of the character and properties of assumed similarity measures. Tech. Report No. 7, ONR contract N6ori-07135, February 1953. (AD 6562)

ASSUMED SIMILARITY MEASURE

Reliability: ASo (determined from differences on items considered separately: .93)
ASp (determined from differences on items considered separately: .83)
ASn (determined from differences on items considered separately: .95)
Split-half reliabilities determined by rho (N = .39).

Factors: and their split-half reliabilities, corrected by Spearman-Brown formula, determined from test responses following 4 different sets of directions (N = 72):
Self-confidence: ranged from -.02 to .61 (3 of 4 ranged from .46 -.61)
Gregariousness: ranged from .21 to .74 (3 of 4 ranged from .51 -.74)
Reflectiveness: ranged from .21 to .50 (2 of 4 ranged from .47 -.50)
Aesthetic Values: ranged from .31 to .70 (2 of 4 ranged from .64 -.70)
Cluster IV: ranged from -.07 to .40

Measures: Results of other correlations caused authors to state that "...beyond question...Assumed Similarity is a mental set or perceptual tendency which influences a person's behavior regardless of the content of the items he is marking." They feel that a high AS score may indicate a greater tendency to perceive others as alike.

238. Datel, W. E., Hall, F. D. and Rufe, C. P. Measurement of achievement motivation in army security agency foreign language candidates. Educational and Psychological Measurement, 1965, 25, 539-545.

CALIFORNIA PSYCHOLOGICAL INVENTORY AND ACHIEVEMENT MOTIVATION

Subjects: 290 army security agency soldier-students

Method: Three scales from the CPI (Achievement via independence, Intellectual efficiency, and Achievement via conformance) were added to the usual test battery used for screening prior to full time study of a foreign language.

Results: The attrition rate for the group was 7.2%. The three CPI scales significantly differentiated between the success and failure groups. The traditional battery measures failed to do so. A construct of "achievement motivation" is suggested.

239. Eilbert, L. R., and Glaser, R. Differences between well and poorly adjusted groups in an isolated environment. Journal of Applied Psychology, 1959, 43, 275-278.

ADJUSTMENT TO ARTIC ISOLATION

Subjects: 648 enlisted AF personnel assigned to 8 Artic bases. Median age of 20 years, range of 18 to 47 years. Subjects had been isolated from 2 to 12 months with a mean of 7 months.

Method: Adjustment was defined as effectiveness on job and ability to get along with others. Immediate supervisors rated their men as positive or negative on a nine item scale. Subjects were those more than one sigma above or below the mean. Well adjusted group consisted of 112 men, poorly adjusted group consisted of 83 men.

Results: The following are the tests which differentiated between the two groups significantly. Further test description and scoring procedures may be obtained from the article. Biographical Inventory: 30 of the 150 item inventory differentiated, significant at $p < .10$. Self-Appraisal Blank: 42 forced-choice descriptions. Significant at $p < .01$. Incomplete Sentences Test: 70 items based on Holsopple and Miale Test and the Incomplete Sentences Test for Pilots. Significant at $p < .01$. Peer Nomination Form: Significant at $p < .001$, i.e., peer and supervisor ratings agree. Job Proficiency Tests: Significant at $p < .001$. Aptitude Scores: drawn from Airman Classification Battery and Airman Qualification Examination. Significant at $p < .05$. NOTE: a modified version of the Taylor MAS was used but apparently did not differentiate.

240. Eron, L. D. and Auld, Jr., F. A study of the Thematic Apperception Test stories and sentence completions of subjects in Operation Hideout. Report No. 243, Vol. XIII, No. 4, Project NM 002 015.11.02, Medical Research Lab., Bureau of Medicine and Surgery, Navy Department. Department of Psychiatry, Yale University School of Medicine, February 4, 1954. (AD 36 749)

TAT AND CONFINEMENT IN OPERATION HIDEOUT

Method: 23 volunteers participated in Operation Hideout, a confinement of two months in a partially activated fleet-type submarine of which 6 weeks was spent in an atmosphere containing 1.6% CO_2. For further details see reference no. 328. The subjects were tested on the TAT once at the beginning of confinement and again near the end of confinement. The data was also compared with a sample of 100 randomly selected submariners.

Results: In general, the subjects were found to be more emotionally neutral and action oriented than the random sample of submariners. Also the random sample contained"...significantly more individuals who felt some social responsibility and significantly fewer individuals who wanted to get out of "messy" details." (p. iii)

Comparing the results of the first and second TAT testing of the confined subjects, the authors commented that, "...it was apparent that the subject became increasingly uncooperative, more apathetic, more desireous to leave, and had markedly heightened sexual fantasy. Increased references to sickness and ill-health were also noted in the (sentence) completions, as well as a heightened concern over whether they were doing the right thing in their relation to their peers." (p. iii)

241. Fiedler, F. E. Assumed similarity measures as predictors of team effectiveness in surveying. University of Illinois, College of Educ. Tech Report. No. 6, 1953. (Also available in Journal of Abnormal and Social Psychology, 1954, 49, 381-388)

ASSUMED SIMILARITY MEASURE

Results indicated that more congenial team is less effective.

ASo of most preferred member correlates -.51 to -.58 with surveying team effectiveness, significant at $p < .025$.

II. C. Tests, Personality and Interaction Dimensions

242. Fiedler, F. E. Leader attitudes and group effectiveness. Final report of ONR Project NR 170-106, N6-ori-07135. Urbana, Illinois: University of Illinois Press, 1958.

AS and ASo TESTS

"...scores based on the perception of similarity rather than real similarity in personality attributes emerged as the most fruitful independent variables in our research." (p. 2, underlinings are not the author's)

Test contents, scoring procedures, interpretation and reliability data are given in the text.

Subjects: for all the studies given, the subjects were male, from high school age on. All of the groups studied had been in existence prior to testing, from a few weeks to several years, for some particular purpose. Types of groups included bombing crews, basketball teams, surveying teams, boards of directors, etc. Effectiveness measures were in terms of the teams' product.

Cost: 24 item test, repeated on 3 to 6 sheets depending on perceptions required by experimenter. Requires approximately 3 min. per sheet. Two computer scoring methods have been developed (pp. 16-17).

Data: No norms
Reliability: .93 by Guttman split-half formula on N = 200

Description: AS score: comparison of subject's self-description with his description of another person. ASo score: compares subject's description of his most preferred to his least preferred co-worker.

Measures: "measures an attitude toward others which may best be described as emotional or psychological distance." (High implies closeness, low score implies distance.)

Use of test as a predictor: Test is a predictor of team performance by means of the formal leader's ASo score only if other interacting variables are considered, i.e., the groups sociometric structure (formal vs. informal), leader-keyman relationship, and the demands of the task. A necessity for prediction from the leader's ASo score is group acceptance of the leader as determined by a sociometric rating scale. For task groups, an amount of psychological distance is required whether a result of the leader having a low ASo score or a low sociometric acceptance for his keymen.

II. C. Tests, Personality and Interaction Dimensions

For basketball (9 to 18 members each) and surveying (3 to 4 members each) teams the correlations of team effectiveness with the ASo score of the most preferred co-worker (informal leader) were as follows:

	Number of teams	Mid-season Correlation	End of season Correlation
Basketball teams I	14	-.69	-.44
Basketball teams II	12	-.58	-.35
Surveying teams	22	-.51	

243. Fiedler, F. E. A Contingency model for the prediction of leadership effectiveness. Office of Naval Research Contract NR 177-472, Technical Report No. 10. Group Effectiveness Research Laboratory, Dept. of Psychology, University of Illinois, Urbana, Illinois, May, 1963. (AD 409 275)

LEADERSHIP - CONTINGENCY MODEL

Favorableness of the group-task situations for the leader proposed to be primarily dependent on three dimensions:

I. Affective relationship between the leader and his members.
II. Power inherent in the leadership position. Rated on the following:
  a. Leader control of reward and punishment
  b. Leader control of group procedure
  c. Leader control over members' jobs
  d. Members' control over leader status
III. Degree to which the task is structured. Rated on the following:
  a. Decision verifiability
  b. Goal clarity
  c. Goal path multiplicity
  d. Solution specificity

Author assigns high and low levels to each of the above dimensions giving him an 8-celled cube. The author states it is possible to"...develop a pattial order of the various task-situations in terms of their favorableness or "advantage to leader". We can then determine the direction of the correlations between the leader's LPC (or ASo) scores and the group's effectiveness within each of the eight octants." He assumes that the order of decreasing importance is: I, III, II. Summarizing his own research over 54 groups in terms of the eight octants, the median correlations of the group performances with the leader's LPC scores ranged from .05 to -.67 with a mean of .44.

By plotting the median correlations against the collapsed dimensions the author was able to make the following comment re: effective group performances and leader LPC scores: "...the controlling, managing, and directive (low LPC) leaders are better able to cope with group task conditions which are either very favorable or very unfavorable. The permissive, considerate, passive (high LPC) leaders tend to perform best under moderately favorable or unfavorable conditions..."

COMMENTS RE LEADER'S IQ AND ABILITY SCORES AND GROUP PERFORMANCE: "Our research has shown that the leader's intelligence and ability scores correlate positively with group performance only when (a) the leader is sociometrically accepted by his group, (b) the group is cohesive, or (c) it operates under relatively stress free conditions."..."In uncohesive or stressed groups, the leader's ability scores correlated negatively or near zero with group performance." (p. 17)

LEAST PREFERRED COWORKER (LPC) SCORE

Description: Same test as the ASo test but the LPC score is obtained by summing the item scores of the individual's ratings of his least preferred co-worker. A high, or favorable score indicates high LPC. (The ASo compares the descriptions of the most and least preferred co-worker). Like the ASo, the LPC is generally obtained either before the person has had contact with his group or on persons he has worked with some time in the past.

Data: LPC correlates from .80 to .95 with the ASo score.

Measures: High LPC score indicates person who is: relatively permissive, considerate of the feelings of others, inclined to be compliant, and encouraging of good interpersonal relations among group members. Low LPC score indicates a person who is: controlling, active, directive, more task- than satisfaction-oriented and more punitive in his behavior as a leader.

244. Fiedler, F. E. and Meuwese, W. The effect of stress on the contribution of member intelligence to group creativity. Technical Report No. 29, Contract NONR-1834(36), ARPA order -454, Project NR-177-472, Group Effectiveness Research Laboratory, Illinois University, Urbana, Illinois, January 1966. (AD 627 359)

II. C. Tests, Personality and Interaction Dimensions

GROUP MEMBER IQ AND STRESS

Method: Three conditions of experimentally created stress and varying degrees of leader anxiety.

Results: Non-stress, low leader anxiety condition: leader IQ as measured by the Cureton Multiaptitude Test, correlates with group performance. Stress, anxious leader condition: member IQ correlates with group performance.

245. Fine, B. J. Introversion-extroversion and motor vehicle driver behavior. Perceptual and Motor Skills, 1963, 12, 95-100.

MMPI AND DRIVER BEHAVIOR

Subjects: 993 male college students

Method: The subjects were administered the MMPI during their freshmen year. The performance data was collected five to seven years later and apparently was a cumulative measure dating from the time the driver's licenses were first obtained. The performance measure was the number of traffic accidents and violations that had occurred. The subjects were split into extrovert, intermediate, and introvert groups on the basis of an MMPI-derived Internalization Ratio.

Results: The Extroverts had significantly ($p < .01, < .02$) more accidents and violations than the Introverts. The Extroverts also had significantly more accidents ($p < .01$) and violations ($p < .10$) than the Intermediates. The Introverts and the Intermediates did not significantly differ.

246. Fleishman, E. A. The Leadership Opinion Questionnaire. In R. M. Stogdill and A. E. Coons (Eds.) Leader behavior: Its description and measurement. Ohio State University, Bureau of Business Research, Research Monograph No. 88. Columbus, Ohio: The Bureau, 1957, 120-133.

LEADERSHIP OPINION QUESTIONNAIRE

Data: Norms available (groups only generally described and suggested only as guidelines)

II. C. Tests, Personality and Interaction Dimensions

Reliability: S scale: .79 to .88 on split-half method
.74 and .67 on test-retest
C scale: .62 to .89 on split-half
.80 and .77 on test-retest

Validity: shown independent by factor analysis (S&C), correlations on 13 groups run from .08 to -.23. On ratings done 2 and 3 years after test administration: S scale showed no relationship to criterion; C scale correlated .29 and .32 with the rating criteria.

Description: 2 groups of 20 questions each on which person picks one of 5 alternatives of what he, as supervisor, should do.

Measures: Structure (S): extent to which an individual is likely to structure his own role and those of his subordinates toward goal attainment. Consideration (C): extent to which person is likely to have job relationships characterized by mutual trust, warmth, etc. To be used on active and prospective supervisors.

247. French, R. L., Knoell, Dorothy M. and Stice, G. F. Measures of attitudes and performance during early training as predictors of B-29 crew performance in Korean combat. An unpublished draft. Reports 358.9, C2, 56-4, Project 7713, Task 77230, Lab Note CRL-LN-56-4. USAF AFP & TRC Library, AFL 2870, Crew Research Laboratory, AF Personnel and Training Research Center, Air Research and Development Command, Lackland AFB, Texas, March 1956.

COMBAT PERFORMANCE PREDICTION FROM EARLY TRAINING ATTITUDES AND PERFORMANCE

Method: The performance of B-29 crews (N = 22 to 53) during training and during Korean combat was correlated. The training measures included both performance measures (rated performance on training missions, ground school grades, over-all performance rating, radar bombing error, accuracy of visual target identification, and control time error) and Attitude Scale Measures (sense of well-being in Air Force, confidence in Air Force management, sense of safety in B-29 flying, liking for own crew, liking by own crew). The Korean combat performance was rated by superior officers.

Results: The better predictors were the mean crew attitude and the individual training performance. The correlations between mean crew training performance measures and rated crew combat performance were not significant and one (over-all rating) was unexpectedly and definitely (-.22) negative. The only definitely positive correlation trend was between training mission and combat performance. All of the mean crew attitude measures correlated significantly with combat performance, two at the .05 level and three at the .01 level. Only 3 of the 35 individual correlations between the 7-member crew and the attitude measures attained significance - in a relatively random manner. On the other hand, more significant correlations with combat performance occurred in the matrix of individuals and performance training measures. Of the performance measures, rated performance on training missions and control time error correlated at the .05 level for two and three crew members, respectively. The bombardier correlated significantly with two performance measures, ground school grades and accuracy of visual target identification. The unanswered question, as the authors point out, is how much objectivity was present in the superior officers' ratings of combat performance.

248. Freeman, M. J. The development of a test for the measurement of anxiety: a study of its reliability and validity. Psychological Monographs, 1953, 67 (3), Whole No. 353.

FREEMAN MANIFEST ANXIETY TEST

Measures: overt abnormal fears and apprehension, i.e., differentiates manifest anxiety (MA) cases from the "normal" (N) population.

Description: 141 two or three choice items. Many of the items require some self identification to answer. Administration, scoring, phi values, and complete test given in the article. Individual or group administration.

Subjects: 921 subjects including patients (30 day observation and agreement on diagnosis of either normal, neuropsychotic, or gastrointestinal with no physical basis), job applicants (salesmen & clerical workers), and students.

Data: Validity: 771 subjects used for item validation (N and MA). Test differentiated best on study using 116 nonhospital Ns and 150 hospitalized MAs. 12 items significant at $p<.05$ and 28 items sig t $p<.01$. Short form of 103 items possible. Comment: Although carefully constructed to avoid faking, the instructions might have affected differentiation between Ns and MAs; i.e., "your employment depends on this" vs. "to help our diagnosis." Reliability: 100 Ns used. .73 reliability obtained using Kuder-Richardson formula #21 and scoring according to a procedure. Norms: based on 100 Ns and 100 MAs.

249. Gelbmann, F. J. Authoritarianism and temperament. Washington, D. C.: Catholic University of America Press, 1958.

AUTHORITARIANISM

Procedure: 149 white male fireman given Calif F Scale (forms 40 & 45). The extreme scorers (16 at each end) were then given the Guilford-Zimmerman Temperament Survey and the Mann Whitney test.

Results: GZ Temperament Survey did not differentiate the two groups. Only the Friendliness score on the Mann Whitney test differentiated them.

The author suggests redefinition of authoritarianism is needed and either differences are not that great, or it is a circumscribed rather than a general trait, or these two tests do not tap the authoritarianism dimension.

250. Ghiselli, E. E. Traits differentiating management personnel. Personnel Psychology, 1959, 12, 535-544.

SELF DESCRIPTION INVENTORY

Measure: IQ, supervisory ability, initiative, self-assurance, and occupational level.

Data: validity (review of previous studies): IQ: correlation with IQ test was .57. Supervisory: correlation with ratings by supervisors for 469 subjects was .48. Initiative: correlation with ratings

by supervisors for 20 and 12 men was .50 and .75. Self-assurance: correlation with self ratings of general effectiveness for 21 personnel officers was .37. Correlation with ratings of 14 men applying for management positions was .66. Correlation with ratings by superiors of self-assurance for 12 general insurance agents was .66. Occupation level: higher occupations earn higher scores than lower occupations.

Reliability: Using Kuder-Richardsons Formula 20 for 300 standardization subjects:

Intelligence: .78
Self-assurance: .56
Supervisory: .73
Occupational level: .90
Initiative: .85

Norms: the mean scores and standard deviations are given for the five scores for the following groups of subjects: 113 in top management, 176 in middle management, 172 in low management, and 319 white and blue collar workers. Several of the group means were significantly different at the .01 level.

251. Ghiselli, E. E., and Lodahl, T. M. Patterns of managerial traits and group effectiveness. Journal of Abnormal and Social Psychology, 1958, 57, 61-66.

DMA SCALE

Subjects: 90 college males used in 10 groups each of 2, 3, and 4 members. The subjects had no prior acquaintance with each other nor experience with the task.

Task: two model trains running in opposite directions for 12 three minute trials with a one minute rest. Controls permitted simultaneous operation by 4 men. Productivity score was result of 4 measures of trips completed with both trains. Carefulness score was result of 4 measures of wrecks and derailments. Task required close cooperation among all members in order to obtain a productivity score and was considered to be fairly complex.

II. C. Tests, Personality and Interaction Dimensions

Data: A supervisory scale from the Self Description Inventory was also administered but scores did not correlate as well with the task data and correlated only .365 with the DMA scale. Apparently the authors weighted the DMA scale such that a high score would reflect the dynamic type of decision making. Using standardized scores, a high skewness score for a group would indicate that there was a large score difference between the top scorer and the next highest scorer, and that there was a small score range between group members scoring less than the top scorer.

DMA scale Coefficients of Correlation

Type of score	Productivity	Carefulness
Mean score for group	.165	-.362*
Highest score in group	.265	-.237
Difference between the 2 highest scores	.435**	-.130
Positive skewness of group score@	.815****	.249

Type of score	Positive skewness	Productivity
No. of grp organization chgs	-.47***	-.64***
No. of grp methods changes	-.60***	-.55***

*p<.05, **p<.02, ***p<.01, ****p<.001, @ groups containing 3 and 4 members only

252. Gibbs, C. B., Leonardo, R. and Rowlands, G. F. The effects of psychological stress upon decision processes and the speed and precision of tracking movements. I. A study of the effects of sleep deprivation and disturbance. National Research Council of Canada report no. NRC-10397, 1968. (N69 10528)

The study investigated the effects of sleep deprivation and sleep disturbance on performance on a mirror tracing task and a step-input tracking device. Measures were taken on a set of tests including the Standard Progressive Matrices test, the Eysenck Personality Inventory, and the High School Personality Questionnaire. Several of the personality measures correlated with the performance measures at .6 to .7.

II. C. Tests, Personality and Interaction Dimensions

253. Glickman, A. S., and Vallance, T. R. Development and validation of an experimental battery to select officer candidates for the Navy. Technical Bulletin 54-12, Bureau of Naval Personnel, Personnel Analysis Division, Washington, D.C. July 20, 1954. (AD 38 766)

THE PREDICTION OF OFFICER CANDIDATE SCHOOL

Tests used: Officer Qualification Test (OQT): measures intellective abilities of a verbal, mechanical, and mathematical nature. Has been used by Navy since 1943 and has demonstrated validities around .50 in prediction of achievement at officer training schools. Source of test and data given in report. U-score: the college attended and the major subject afforded two weights based on the percentage in a category who had graduated from OCS (total N = 4352 Ss). U-score is the sum of the two weights. Level of Academic Aspiration (LA-A): 4 questions re: "percent of his class mates whom he will exceed." Level of Military Aspiration (LA-M): 4 questions re: predicted military aptitude assessments by officers of the OCS staff. Level of Aspiration-Peer Rating (LA-PR): 4 items requiring a self-estimate of how he would be judged by his peers. 15 minute total test time for combined aspiration test. Verbal-Numerical Test (VNT): purposed to measure level and stability of performance under difficult conditions. Consists of 5 sets of 20 verbal-numerical problems administered under successively shorter time periods. 50 min. total time exclusive of instructions. Calif F-scale: 15 minutes test time. Naval Knowledge Test (NKT): source of test and data given in report. 69 item test, correlated from .33 to .53 with OCS academic criteria in previous studies, presumed to measure interest and motivation of the civilian towards Navy. 45 minutes test time. Leadership Opinion Questionnaire-Initiating Structure and Consideration (LOQ-S & LOQ-C): a slight modification of Fleishamn's LOQ. 20 minutes test time.

Method: tests administered as part of normal in-processing procedure before classes began. Data from "civilian" students was used on three companies: A (133 Ss) (B 134 Ss) and C (141 Ss). Original validation done on A and C, cross validation done on Company B. Criterion was the sum of grades received on 6 OCS subjects at the end of the first month.

II. C. Tests, Personality and Interaction Dimensions

Results: Intercorrelations of predictor and criterion variables were:

U-score	.342
LA-A	.364
LA-M	.078
LA-P	.050
VNT	.461
F-Scale	-.211
NKT	.370
LOQ-S	-.046
LOQ-C	.100
OQT	.557

The best predictor resulted from a combination of OQT, VNT, NKT, and U-score (A & C, 274Ss). The "shrunken" multiple-R of the combination was .675, as compared to .557 of the OQT alone. Cross validation on Company B gave a multiple-R of .685 for the combination test predictor.

254. Goldberger, L. and Holt, R. R. A comparison of isolation effects and their personality correlates in two divergent samples. ASD Tech. Report 61-417, Contract No. AF 33(616)-6103, Biomedical Lab., Aerospace Med. Lab., Aeronautical Systems Div., AF Systems Command, USAF, Wright-Patterson AFB, Ohio, August 1961. (AD 268 172)

ISOLATION CORRELATES

Summary: a replication of an earlier study (ref. no. 268) is made using 16 unemployed actors as subjects. The data from the two studies are compared with respect to the correlates to the adaptive and maladaptive syndromes. Although several of the test measures and ratings correlated significantly with behavior in only one study or correlated in the opposite sense, the authors point to "ego-strength" as being a higher-order variable which is coordinated with the isolation adaptive syndrome in both of the two divergent subject samples. The authors define "ego-strength" as: "physiological stability and good health, a strong sense of reality, feelings of personal adequacy and vitality, permissive morality, lack of ethnic prejudice, emotional outgoingness and spontaneity, and intelligence." (p. 40) The authors also stress "...the salience of intellectual flexibility, breadth and richness and emotional freedom...across sample differences." (p. 41)

Some specific comparisons of adaptive reaction correlates in the two studies: Test measures: Barron's Ego-Strength Scale and the MMPI Hypochondriasis scale correlated significantly in both studies. Morris's Paths of Life, Path 3 (Nurturant love of others), correlated significantly in the opposite sense in the two studies. Ratings: Ratings on aesthetic, economic and creative aspects and on stereotype and inhibition correlated significantly in the same sense in both studies. Ratings on femininity vs. masculinity correlated significantly in the opposite sense in the two studies.

255. Gorfein, D. Conformity behavior and the "authoritarian personality." Journal of Social Psychology, 1961, 53, 121-125.

CONFORMITY TEST

Materials: (a) Standard brown triangle: altitude 9 cm, base 4.5 cm; mounted on board. (b) Adjustable triangle mounted on support, operated by pulleys and calibrated in cms. (c) Substitute triangle twice as thick as the adjustable triangle.

Procedure: Part A: The subject is seated and the standard triangle is placed one yard in front of him to his left at eye level. The adjustable apparatus is set up at two yard intervals from 3 to 9 yards. The subjects were asked to match in size the adjustable triangle to the standard by pulling a cord which was attached via pulleys to the adjustable triangle. 3 estimations were made at each of the four distances for a total of 12 estimations. Part B: The experimenter next takes the triangle of greater depth and says: (tries to influence subject to increase his error). Experimenter pretends to switch triangles, but actually leaves the original triangle. Score is the absolute value of Part A - Part B.

Results: 10 subjects also performed in an Asch-type of situation. The correlation between the two was .56.

CALIF F SCALE VS. CONFORMITY MEASURES

Subjects: 40 college students; 14 subjects on Asch-test only, 16 subjects on other test, 10 subjects on both tests.

II. C. Tests, Personality and Interaction Dimensions

Summary: "A replication of Asch's group influence experiments and a prestige-suggestion experiment was administered to a number of students who had previously taken a version of the California F-scale. No significant relationship was found between F-scale scores and behavior in these experimental situations."

Rank order correlations obtained:

	Experiment A Group influence	Experiment B Experimenter influence
F-scale	-.14	.09
Experiment A	--	.56 (based on 10 Ss)

256. Hackman, J. Richard. Tests, Questionnaires and Tasks of the Group Effectiveness Research Laboratory: 1951 - 1964. Technical Report No. 24, Office of Naval Research Contract NR 177-472, Nonr-1834(36). Group Effectiveness Research Laboratory, Dept. of Psychology, University Of Illinois, Urbana, Illinois, July 1965. (AD 623 312)

TESTS, QUESTIONNAIRES, AND TASKS USED FOR GROUP RESEARCH BY GERL

A description, a sample item, and references covering the use of the test instrument are given for the following:

Tests: Anxiety Differential, Calif F Scale, Category Width (broad or narrow categorization tendency), Dogmatism Test, LSU Interest Inventory, Kluckhohn Value Orientation (measures basic values), Multi-Aptitude Test.
Questionnaires: The Semantic Differential, Assumed Similarity between Opposites, Least-Preferred Co-Worker, Behavioral Differential and Social Distance Scales, Group Atmosphere Questionnaire, Behavior Description Questionnaire, Post Meeting Questionnaire, Satisfaction Scales, Sociometric Questionnaires.
Group Tasks: Shaw's Dimension Scores and Fiedler's Task Structure (TS) Scores are discussed. (see below) TS scores are given for these tasks: basketball game, open hearth steel production, land surveying, anti-aircraft artillery crew tasks, B-29 bomber crew target hits, military tank movement and target hits, golf competition, rifle firing, disassembly and reassembly of a pistol. Other group tasks described include: group and individual administration of creativity tests (Plot Titles, Alternative Methods Test, Consequences, Unusual Uses and the Thematic Apperception Test) and group preparation of stories or group problem solutions upon presentation of some stimulus (several are described).

II. C. Tests, Personality and Interaction Dimensions

Copies of the following tests and questionnaires are presented in the appendix: Behavior Description Questionnaire, Group Atmosphere Scale, Hulin Satisfaction Scales, Interpersonal Perception Scales (Most Preferred Co-Worker and Least Preferred Co-Worker), Kluckhohn Value Orientation (McGrath adaptation), Post-Meeting Questionnaire (with sociometric item), and a sociometric scale.

SHAW'S TASK DIMENSION SCORES AND FIEDLER'S TASK STRUCTURE SCORES

Shaw's ten task dimension scores are presented and described. A footnote comments that "Shaw has factor analyzed these a priori dimensions, and on the basis of the factor analysis, selected six of the original dimensions for further development. These dimensions are difficulty, cooperation requirements, solution multiplicity, intellectual-manipulative requirements, intrinsic interest, and population familiarity." (p. 27)

It appears that the six dimensions selected by Shaw for further development are related to behavioral characteristics while the other four are related to task structure. Fiedler has used these four (decision verifiability, goal clarity, goal path multiplicity (reversed scoring), and solution multiplicity (reversed scoring) to develop an operational definition of task structure. The TS scores range from 1 to 8, 8 representing a high structure. The scoring is further detailed in the article and several of the described group tasks are assigned TS values.

257. Halcomb, C. G. and Kirk, R. E. Organismic variables as predictors of vigilance behavior. Perceptual and Motor Skills, 21, 1965, 547-552.

THE CPI AND THE WONDERLICK PERSONNEL TEST-PREDICTORS OF VIGILANCE BEHAVIOR

Subjects: 40 male college students

Tests: 6 scales of CPI: dominance, achievement via independence (AI), social presence, responsibility, flexibility, and self-control. Wonderlic Personnel Test, Form D, 1922: IQ

Task: 4 hours of monitoring a CRT display for a .25 second horizontal deflection.

Results: self-control: high scorers had a slower performance decline, significant at p .05. Correlation r = -.51, sig at p<.01. Flexibility: less flexible subjects had a higher reaction time, significant at p<.05. AI and IQ: high scorers on both performed better and showed no decrement in performance, significant at p<.01.

258. Harrell, T. W. Personality differences between extreme performers during a fourth discussion session. Technical Report No. 12, ONR contract Nonr 225 (62), NR 171 388. Graduate School of Business, Stanford University, Stanford, California, August 1966. (AD 637 823)

PERSONALITY AND DISCUSSION GROUP PERFORMANCE

Subjects: 23 five-man discussion groups composed of MBA students.

Method: four meetings of each group occurred during a three to six month period. 30 minutes were allowed to reach a decision on human relations problems. Upon termination, sociometric questionnaires were completed asking who had the best ideas, guidance, leadership, most participation, and the ranking of other members on being liked. Quanity of communication per subject was also scored. Tests taken by the subjects included: Strong Vocational Interest Blank, MMPI, Guilford-Zimmerman Temperament Survey, Leadership Opinion Questionnaire, Ghiselli Self Description Inventory, Personnel Problems, Public Opinion Survey, Test of Imagination using the TAT, and an Individual Background Survey.

Results: Most of the scales from the above tests differentiated between the extreme performers on one or more of the performance criteria.

259. Havron, M. D., Fay, R. J., and McGrath, J. E. The effectiveness of small military units. Part I. The measurement of Infantry Rifle Squad effectiveness, Part II. Handbook: construction and use of small unit field tests, and Part III. The prediction of field performance. Personnel Research Section Report No. 980. Institute for Research in Human Relations, Washington 6, D.C., September 1952. (ATI 171 966, REEL C6794)

II. C. Tests, Personality and Interaction Dimensions

ARMY GROUP COMPOSITION BATTERY: PREDICTION OF FIELD PERFORMANCE

Several measures were developed and administered to Infantry Rifle Squads. The measure development, administration, the results obtained and the discussion of results are included in this report. Copies of these test instruments are given in a separate Technical Appendix, Appendices D through G. The mean test measure performances were correlated with a mean Rifle Squad Field Problem (RSFP) score. The altitude measures included: Authoritarian, Authoritarian plus Non-Conformist scores, Equalitarian, Non-Conformist, General Army Adjustment, Level of Aspiration, Paranoid Tendencies, Physical Prowess, Self Reliance, Peripheral Nervousness, and Social Activeness. The significant correlations are given below (* implies .01 level):

Squad Sigma: Non-Conformist -.26*, Level of Aspiration -.29*, and Physical Prowess -.23.

Squad Mean: General Army Adjustment .25, Paranoid Tendencies -.23, Physical Prowess .37*, Peripheral Nervousness -.27*, and Social Activeness .25.

260. Haythorn, W. The influence of individual members on the characteristics of small groups. Journal of Abnormal and Social Psychology, 1953, 48, 276-284.

CATTELL'S 16 PERSONALITY FACTOR QUESTIONNAIRE

The "emotional stability vs. general neuroticism" correlated with group effectiveness at r = .48. The emotional stability vs. general neuroticism correlated with job completion rating r = .43.

The factor M, "bohemianism vs. practical concernedness" correlated with a rating of group productivity at r = -.61, and with rated job completion at r = -.43.

261. Haythorn, W. W., Altman, I. and Myers, T. I. Emotional symptomatology and subjective stress in isolated pairs of men. Journal of Experimental Research in Personality, 1966, 1, 290-305. (Also available as AD 649 888)

II. C. Tests, Personality and Interaction Dimensions

DYAD COMPOSITION AND COMPATIBILITY UNDER CONFINEMENT

Subjects: 36 volunteer Navy recruits, 18 experimentals and 18 controls.

Tests used: Three scales from Edwards Personal Preference Schedule (Achievement Need, Dominance Need, Affiliation Need), Rokeach's Dogma Scale, Subjective Stress Scale (SSS), and the Subjective Symtomatology Questionnaire (SSQ).

Method: 3x3 Greco-Latin square design on the four personality characteristics such that each had homogenous high, hetero- and homogenous low dyad compositions represented. Experimantals lived and worked in a small room with minimal outside contact for 10 days. The dyads were strangers matched on other characteristics. Upon termination of the experiment (and also at a time prior to involvment in the experiment) the subjects completed the SSS and the SSQ. (SSQ differentiates between experimentals and Controls' emotional responses to deprivation.)

Results:

SSQ - dogmatism: heterogenous dyads significantly responded more emotionally to the confinement situation, becoming apparently more intraceptive.

SSQ - Achievement need: heterogenous dyads significantly suffered greater disturbance under confinement.

SSS - dominance need: greater stress was felt by both high and low homogenous groups, but not by the heterogenous dyads.

SSQ - dominance need: more symptoms were experience by both homogenous dyads.

SSS - affiliation need: the heterogenous dyads suffered greater stress.

SSQ - affiliation need: the heterogenous dyads experience more symptoms.

In general, the experimentals and the controls did not react very differently to the experimental situation. The authors felt the reason for this lay in the fact that although the controls were not confined in the same sense, they were new recruits on their first assignment and thus relatively isolated.

262. Haythorn, W., Couch, A., Haefner, D., Langham, P., and Carter, L. The effects of varying combinations of authoritarian and equalitarian leaders and followers. Journal of Abnormal and Social Psychology, 1956, 53, 210-219.

II. C. Tests, Personality and Interaction Dimensions

CALIF F SCALE - LEADER AND FOLLOWER COMPOSITIONS AND INTERACTIONS

Subjects: 32 male college men: high F scale score, conservative 16 F score, and normal MMPI. 32 male college men: low F scale score, liberal 16PF score, and normal MMPI. 4 four-man groups of each of four different leader-follower compositions. Task of discussing a specific human relations problem was repeated for three sessions. Sessions 2 and 3 had appointed leaders and, each time, an "alien" member and a different leader.

Measures: 17 behavioral acts were rated by observers, a Post Meeting Reaction Sheet for qualitative statements and sociometric rankings completed by both subjects and Os, and 16 behavioral traits were rated by observers as follows: striving for individual prominance, friendliness, security, influence, equalitarianism, striving for group approval, submissiveness, striving for goal achievement, self-isolating behavior, effective intelligence, sensitivity to others, leadership, aggressiveness, autocratic behavior, social ability, and nonadaptability.

Data: a number of significant interactions in trait ratings and behaviors were found depending on whether leader was high F or low F and on whether the group of followers were high or low F.

LEADER-FOLLOWER PERSONALITY INTERACTION

"...indicates that the behavior of leaders is, to a significant degree, a function of the attitudes or personality characteristics of the followers. Conversely, the behavior of followers is found to be significantly a function of the attitudes or personality characteristics of the leaders." (p. 218)

263. Helmreich, R. L. Prolonged stress in Sealab II: a field study of individual and group reactions. Tech report no. 1, Engineering Psychology Branch, Office of Naval Research, Grant Nonr (G) 00030-66 and Group Psychology Branch, Office of Naval Research, Grant Nonr (G) 00012-66. Yale University, New Haven, Conn., May, 1967. (AD 651 974)

SEALAB STUDIES

Subjects: 28 volunteer divers selected on the basis of diving ability and experience.

Method: Three 10-man teams were each submerged in a sealab for 15 days (26 subjects for 15 days each, 2 subjects for 30 days each). Television observations were made of the subjects. The subjects had a full daily schedule of sorties from the lab, manual performance tasks outside the lab, and housekeeping duties. The environment was a very hostile one including the stresses of: constant danger to life from a variety of sources, painful scorpion stings, difficult verbal communication (helium atmosphere), an extremely crowded and uncomfortable sealab, and situational escape was impossible.

Measures and observations: sociometric measures of ranked leader and teammate choices made pre- and post-submersion; performance measures included number of manual tests completed, sorties made and their duration; frequent TV observations of individuals and group interactions; personality scales administered prior to submersion; and individual daily completion of a Mood Checklist.

Results: The choices of leader did not correlate with experience, performance or sociability. The choices of leader did correlate with age (.51, sig. at $<$.01) and with the Maturity Scale (.41, sig. at .05). The Maturity Scale, it S mean and standard deviation, is given in the appendix of this article and is comprised of 15 items. The author felt that the choice of leader was, therefore a function of dependency needs. The author concluded from a number of the other observations and measures that group relations (inter- vs. intra-group communication, gregariousness, participation in housekeeping activities) are strongly associated with emotional response and performance in stressful situations.

264. Hemphill, J. K. Situational factors in leadership. Columbus, Ohio: Bureau of Educ. Res., Ohio State University, 1949.

LEADERSHIP - GRP JUDGMENT OF ADEQUACY

500 subjects, primarily college students, answered a questionnaire, describing a group of which they were a member, and rating scale on the leader's behavior.

The following correlations between rated leadership adequacy and group dimensions were significant at $p < .01$:

Viscidity: .52
Homogeneity: .29
Hedonic tone: .51

265. Hemphill, J. K. Group Dimensions a manual for their measurement. Columbus, Ohio: Bureau of Business Research, College of Comm. and Admin., Ohio State University, 1956.

GROUP DIMENSIONS DESCRIPTION QUESTIONNAIRE

Measures: Autonomy, control (group regulation of indiv behavior), flexibility, hedonic tone, homogeneity, intimacy, participation, permeability (acceptance of new members), polarization, potency, stability, stratification, viscidity (dissension vs. unity)

Description: 150 questions, each with 5 alternatives, yields description of a group by its members or an individual's orientation towards the group. 45-60 min. group admin.

Data: Tentative norms are available from 950 college student and adult descriptions of various groups. Stanine scores are given based on the score distributions.

Reliability: estimates based on the correlation of odd vs. even items corrected for full length of the dimension:

Miscellaneous groups (N=100): .28 to .92 with 11 dimen at .62 and above
College departments (N=130): .45 to .90 with 11 dimen at .64 and above
Public school system (N=83): .49 to .88 with 10 dimen at .63 or above

Validity: Job satisfaction ratings for two groups (N=128 and 300) correlated at $p < .01$ with hedonic tone, participation, polarization, stratification and viscidity. Productivity in terms of profit for 24 teams in a simulated manufacturing enterprise situation correlated at $p < .05$ with hedonic tone, participation, and viscidity.

266. Hoffman, L. R. Homogeneity of member personality and its effect on group problem solving. Journal of Abnormal and Social Psychology, 1959, 58, 27-32.

GUILFORD-ZIMMERMAN TEMPERAMENT SURVEY

Multisolution, mined road problem: heterogenous group performed better ($p < .05$) producing superior and more inventive solutions.

267. Hoffman, L. R. and Maier, N. R. An experimental reexamination of the similarity-attraction hypothesis. Journal of Personality and Social Psychology, 1966, 3 (2), 145-152.

SIMILARITY OF GROUP MEMBERSHIP

For problem-solving groups, personality, or real, similarity does not produce interpersonal attraction.

Comment: see reference no. 242.

268. Holt, R. R., and Goldberger, L. Personological correlates of reactions to perceptual isolation. WADC Tech. Report 59-735, Contract No. AF 33(616)-6103, Aerospace Med. Lab., Wright Air Division. Center, Air Res. & Division Command, USAF, Wright-Patterson AFB, Ohio, November 1959. (AD 234 003)

PERSONOLOGICAL CORRELATES OF ISOLATION

Summary: The study correlated personality measures with reactions to 8 hours of perceptual isolation and sensory deprivation. From the behavior and verbalizations of 14 freshman male college students 14 reaction measures were obtained. Most of these fell into two internally consistent, not significantly correlated patterns: an adaptive and a maladaptive syndrome. The findings were obtained by correlating rank orders on these syndromes and on each of the fourteen component reaction measures with the various measures of personality.

Subjects: Students scoring above the 40th percentile on the Ohio State Psychological Examination and with non-pathological MMPI profiles were

invited to participate. Several of the respondants were eliminated after a Roschach and an interview as too precarious, leaving 14 subjects. The N for the various measures varies from 10 to 14; 3 of the subjects felt soon after the experiment started.

Method: The various objective and projective tests were taken throughout the year. Reaction measures were the result of observations of the subject during isolation, recordings of the subject's speech during isolation (time period for speech controlled by a signal), and a post-isolation interview.

Tests: Objective tests included: Dynamic Personality Inventory, Morris's Paths of Life, Allport, Vernon and Lindzey's Study of Values, Jenkins' How Well Do You Know Yourself?, Barron-Welsh Art Scale, Stroop Color-Word Interference Test, Holzman-Klein Schematizing test of leveling-sharpening, Witkins Rod and Frame Test and modification of Gottschaldt Embedded Figures Test, Paul's test of memory style, two of Guilford's creativity tests, Brick Uses and Consequences, and the Fantastic Animal drawn by subject before isolation, rated for originality. Projective tests, scored by Q-sort ratings: students autobiography Rorschach, TAT, Wechsler-Bellevue, and an interview conducted after review of the projective tests.

Results: All of the objective tests and the Q-sort clusters correlated significantly ($p < .01, < .05$) with the syndromes and/or with the component reactions except for two. These two were the Consequences test and the Holzman-Klein Schematizing test (which was significant at $p < .10$ for $N = 8$ on one component reaction). Given below are the reaction components (result of intercorrelation) of the two syndromes and the subcategories arbitrarily selected under each reaction component.

Syndome I: Adaptive Reaction to Isolation

Imagery: acceptance of one's passive, feminine side (APF): intellectual flexibility, breadth and richness (IF); Emotional freedom vs. emotional disturbance, constriction or ungenuineness (EF)

Immobility: APF, IF, EF, withdrawal, and achievement drive

Self-stimulation and exploration: IF: EF; self-directed, inhibited aggression; need for response from others.

Verbal output: APF, IF, EF, denial of negative feelings, self-directed aggression, lack of tough 'hard-headed' outlook.
Secondary Process thinking: APF; IF; EF; denial of negative feelings; awareness of inner conflict and self-directed aggression; lack of tough 'practical' outlook.
Controlled and accepted primary process thinking: APF; IF; EF; fearlessness; awareness of inner conflict and self-directed aggression.
Pleasant affect: APF, IF, EF, denial of negative feelings, eagerness to please, lack of tough 'hard-headed' outlook.

Syndrome II: Maladaptive Reaction to Isolation
Quitting: intellectual rigidity and poverty (IR). Poor interpersonal relations, lack of counterphobic determination, inadequacy or weak ego.
Unpleasant affect: Masculine 'hard-headed' interests (MI), IR, Emotional disturbance (ED), other direction and field dependence (FD), poor interpersonal relations.
Impaired secondary process thinking: MI, IR, ED, FD, inadequacy or weak ego.
Poorly controlled primary process thinking: MI, IR, FD, indicators of possible maladjustment.
General disturbance: MI, FD
Sleep: acceptance of passivity, acceptance of primary process.
Stimulus-bound thought: capacity for good social relations, easy and confident

269. Horst, P. Measurement of personality dimensions. Part IV. Experimental applications, Section A. Office of Naval Research Contract Nonr-477 (33) and Public Health Research Grant MH00743-10. University of Washington, Seattle, Washington, May 1966. (AD 482 682)

BEHAVIOR SCALE

Description: 288 item test comprised of 12 items each for 24 rational scales based on Murray's needs. Complete test is given in the article. Factor analysis was performed on the items resulting in (2 groups, N = 145 and N = 211) 10 factors, each with several items with high loadings. Two other factors were also identified but had fewer items and smaller loadings; these were Conformity and a Desire for Change. The ten factors are: Social Dependence, Persistance, Verbal Aggression, Sharp Tongue, Public Spirited, Kindliness, Exhibitionism, Hedonism, Leadership, and Orderliness.

Data: an item analysis and the item and scale loadings on the factors are given in the article. Test-retest reliability per item averaged .585; test-retest reliability per rational scale averaged .8. Several of the correlations between the scales are above .3, indicating that the rational scales are not independent. A principal axis factor analysis was performed on the scales resulting in 10 factors which were not identified by the author.

270. Hyman, H. H. and Sheatsley, P. B. "The Authoritarian Personality" - a methodological critique. In R. Christie and M. Jahoda, (Eds.) Studies in the scope and method of "The Authoritarian Personality." Glencoe, Illinois: Free Press, 1954.

CALIFORNIA F SCALE

Validity based on intensive interviews is questionable as the interviewers were urged to carefully study the subject's completed questionnaire prior to the interviews. There was no independence between the questionnaire and the interview, and, therefore, no objective test of validity.

271. Izard, Carroll E. Personality characteristics associated with resistance to change. Technical report no. 2, contract Nonr 1147(07) with Group Psychology Branch, Office of Naval Research. University of Colorado, July, 1960. (AD 239-506)

EDWARDS PERSONAL PREFERENCE SCHEDULE AND RESISTANCE TO CHANGE

Method: The EPPS was administered to 39 members of a psychology class. At a later date they reported individually to a laboratory where they made 120 estimates of the distance between two fixed points of light in a darkened room. The subject reported his estimates in the first 30 trials. In the subsequent sets of 30, the subject was requested to report "standard" if the distance was within the same range or to report "longer" if the distance appeared to be outside the prior range. The subject was told to expect some of the distances to be "longer." The resistance to change of concept score was the number of "standard" responses made by the subject.

Results: The resistance to change of concept score was correlated with four of the EPPS Scales: Autonomy, Dominance, Deference and Abasement. The Deference and Abasement scores correlated negatively at $p < .05$, while Autonomy and Dominance correlated positively at $p < .05$ and $p < .10$, respectively.

II. C. Tests, Personality and Interaction Dimensions

272. Jensen, A. R., and Rohwer, Jr., W. D. The Stroop color-word test: a review. Acta Psychologica, 1966, 25, 36-93.

STROOP COLOR-WORD TEST

1. Stroop, J. R. Interference in serial verbal reactions. J. exp. Psychol, 1935, 18, 643-661.
2. Thurstone, L. L. and Mellinger, J. J. The Stroop Test. Chapel Hill, N. C.: The Psychometric Laboratory, University North Carolina, No. 3, 1953.

Description: References 1 and 2 above were given as the sources of the most complete detail on two of the more standard forms. Both 1 and 2 used three cards: word, color, and word-color. Stimuli on each card appears in a 10x10 matrix. On the word (W) card, four or five color words as red, blue, etc. appear printed in black ink. On the color (C) card the four or five colors appear as spots of color. On the word-color (W-C) card the word, as red, is printed in a different color, as brown. Usually, the color is named in each of the three situations. 5-8 minutes, individual administration. The authors present several modifications of the test and the sources for further information.

Test Data: test is said to reliably differentiate between individuals and the three scores maintain the same rank order. Scoring: time scores, error scores and performance change scores of all types have been used. Some norms are available. One week test-retest reliability ranges from .71 to .88.

Measures: Factors (N = 436): I. Color difficulty, II. Interference, and III. Speed. The scores which measure these factors are given in the article. W-C card is generally twice as difficult as the other two and is regarded as either a measure of stress reaction or as a creator of stress or conflict. A automatization and flexible control (low interference) measure is obtained by subtracting the C time score from the W-C time score. A review of the research done with the test is given. It has been correlated, with varying degrees of success and with different constraints, with widely disparate factors; from perceptual behaviors to motor learning. The interference score from Stroop has been correlated with a variety of personality tests and factor analyzed with the MMPI. It emerges as a relatively independent factor. The trend of the correlations indicate, however, that low interference subjects tend to have more "ego-strength" and to have more stable personalities. The authors consider the evidence to indicate that the Stroop processes are most related to learning, personal tempo, and response competition.

II. C. Tests, Personality and Interaction Dimensions

273. Kagan, J. and Musse, P. H. Dependency themes on the TAT and group conformity. Journal of Consulting Psychology, 1956, 20, 29-32.

TAT AND GROUP CONFORMITY

Subjects wrote stories to TAT cards. Dependency themes of hero seeking help (most sensitive measurement) and disturbed over loss of love and support predicted yielding in a strong Asch conformity situation at $p < .01$.

Subjects: 27 males

TAT cards used: 1, 6BM, 7BM, 3BM, 12M, 13B, 14, 18BM

Story procedure: $\frac{1}{2}$ page written, 2-3 min. per card.

274. Kassebaum, G. G., Couch, A. S., and Slater, P. E. The factorial dimensions of the MMPI. Journal of Consulting Psychology, 1958, 23, 226-236.

MMPI FACTORS - SCALE ANALYSIS

Factor analysis of 32 scales resulted in two factors and two fusion factors: Factor 1: Ego strength vs. ego weakness - Maladjustment, "general neuroticism, anxiety, dependency and a tendency toward personality and behavior disorders, as opposed to healthy nonanxious personality, absence of disorders and a tendency toward leadership and intellectual ability. Factor 2: Introversion vs. extroversion: Cautious, controlled, inhibited, intellectual, skeptical, intrapunitive personality vs. adventurous, impulsive, expressive, gregarious, naive, extrapunitive personality. Fusion Factor A: Social withdrawal vs. social participation: Shy, seclusive, submissive, guilty, depressed, masochistic vs. poised, sociable, dominant, confident and spontaneous. Fusion Factor B: Impulsivity vs. intellectual control: Impulsive, manic, excitable, erratic, uncontrolled, delinquent vs. responsible, controlled, intellectual, stable, original, intraceptive, insightful.

"...the more MMPI scales included in a factorial study of that instrument, the more closely the results approximate ours." ..."Our analysis essentially replicates Welsh's findings. A is loaded .88 on Factor 1, while R is loaded .69 on Factor II. Both the high loadings and the orthogonality of his scales are reflected in our analysis." Authors comment that, upon rotation of Welsh's 2nd and 3rd factors, his 3rd factor resembles the authors.

II. C. Tests, Personality and Interaction Dimensions

275. King, B. T. Relationships between submarine school performance and scores on the Navy Thematic Apperception Test. Bureau of Med. and Surgical, Navy Department, Research Project NM 23 02 20.01.04. US Naval Med Research Laboratory Report No. 301, Submarine Base, New London, Conn., October 1958. (AD 232 980)

NAVY TAT AND SUBMARINE SCHOOL PERFORMANCE

Summary: some easily obtained "formal" scores suggest the relationship of motivation to comply with instructions and to achieve and of emotional involvement with Submarine School success.

Subjects: Navy Thematic Apperception Test stories were scored for 21 class "drops", for 24 graduates with the lowest final class standing, and 23 graduates with the highest final class standing.

Method: The TAT data was taken when the enlistees entered the school. "Blind" scoring was done for 6 variables, apparently by one scorer. Interrater reliability on one of the variables between 2 raters on 10 subjects was .81. Scoring procedures are given in detail. The six variables were: verbal output (total number of words), uncertainty or qualification, emotional tone of the story (rated on 5-point scale), outcome of the story (best categorization was 3 levels: scorable, questionable, and no outcome), "level" of the story (completeness and enrichment), and "unusual formal characteristics."

Results: Mean verbal output - differentiated between 3 groups at $p < .01$. (analysis of variance). Emotional tone score - differentiated between 3 groups at $p < .01$. (chi square). Outcome score (academic and temperamental drops significantly different) - differentiated between 4 groups at $p < .01$ (chi square). Uncertainty score - no significant difference. "Level" of story score - chi square values sig at $p < .01$. 4 of the categories gave significant differences between the groups at $p < .05$ and $p < .01$. Unusual formal characteristics - chi square values significant at $p < .01$. 3 of the categories differentiated between the groups, significant at $p < .01$.

Analysis of the results obtained above indicated that the dropouts were less compliant with instructions, less productive, and less involved with the test procedure.

Measures: the scoring procedure apparently gives a measure of motivation to achieve and motivation to comply with instructions and of emotional involvement; at least as related to Submarine School success.

276. King, B. T. Predicting Submarine School attrition from the Minnesota Multiphasic Personality Inventory. Bureau of Medical and Surgical, Navy Dept., Research Project NM 23 02 20.01.06. US Naval Research Laboratory, Report No. 313, Submarine Base, New London, Conn., August 20, 1959. (AD 228 417)

II. C. Tests, Personality and Interaction Dimensions

MMPI - PREDICTION OF SUBMARINE SCHOOL ATTRITION

Summary: Attrition in a Submarine School Class was highly related to a weighted combination of an MMPI Attrition Key, pay grade, MECH and ARI.

Subjects: 176 graduates and 74 dropouts (academic and temperamental reasons), enlistees ordered to the Submarine School.

Test descriptions: Navy basic aptitude tests: GCT (General Classification Test) measuring general verbal intelligence, MECH (mechanical) testing mechanical aptitude, ARI (arithmetic) testing arithmetic ability, and the CLER (clerical) which tests clerical ability. The MMPI was scored in the usual way plus some experimental scales were derived from it. The experimental scale which produced significant results was the Attrition Key, consisting of 55 items from the MMPI which differentiated between graduates and dropouts at $p < .05$ or less. The odd-even reliability for this scale was .84. The complete Attrition Key is given in the report along with the response data. Also administered was the PIB.

Results: Background variables: the background variables of age, years of active service, pay grade, and years of education resulted in biserial correlation validity coefficients which were all significant at $p < .001$. The highest coefficient was .51 for pay grade. Aptitude tests: the biserial validity coefficients of the GCT, MECH, and ARI ranged from .30 to .47, significant at $p < .01$. CLER, at .12, was not significant. MMPI: the biserial validity coefficients of the F, Pt, Ma, and Si scales ranged from -.17 to -.19, significant at $p < .05$. The coefficients of the K, Hs, Pd, Mf, and Sc scales ranged from .21 to .24, significant at $p < .01$. Attrition Key: biserial validity coefficient was -.74, significant at $p < .01$. PIB: coefficient was -.18, significant at $p < .05$.

Predictive ability of each of the test scores alone using point-biserial correlations:

Attrition Key	-.56	MECH	.35
Pay grade	.38	ARI	.22
GCT	.26	CLER	.09

Multiple correlation, using beta wts and point-biserial balidity coefficients, with Graduate-fail criterion of Attrition Key, Pay Grade, MECH and ARI was .65. Correlation was given as .86 if a continuous data criterion had been used. Multiple correlation of only two predictors, Attrition Key and Pay Grade, was .61.

277. Kipnis, D., and Wagner, C. Effects of motivation to strive on personality-performance relationships. Journal of Experimental Research in Personality, 1965, 1, 138-143.

II. C. Tests, Personality and Interaction Dimensions

PERSISTENCE TEST AND MOTIVATION

Subjects: 214 Navy enlistees.

Test: Persistence Test - a tiring test given as "a measure of finger and hand dexterity". Test description, instructions, and previous uses are given in the article. The test requires the subject to make tally marks on a series of boxes.

Method: a task of solving anagrams (score was the number solved within a time limit) was administered under two conditions: experimenter induced high and low motivation by means of the amount of importance ascribed to the task.

Results: Low motivation condition: persistence score and anagram performance were not related. High motivation condition: persistence and performance related, significant at $p < .01$.

278. Knapp, R. R. and Most, J. A. Personality correlates of marine corps helicopter pilot performance. MR 005.15-1001.3, Naval Med. Field Res. Lab., Camp Lejeune, North Carolina, August 1960. (AD 244271)

GZTS, MMPI AND O-A Personality Test Battery and helicopter pilot performance.

Tests: MMPI scored on the 9 standard clinical scales. GZTS contains 300 items which are scored on 10 scales and a ? category. Objective-Analytic Personality Test Battery including miniature situational tests and various tests of speed and accuracy in many performances, preference questionnaires, some projective or apperceptive tests, etc. Only group tests were used giving scores on 12 factors.

Subjects: 81 Marine Corps officer helicopter pilots selected on basis of availability. Mean education of 15 years with range of 11 to 18 years. Mean age of 25 years with a range of 21 to 38 years.

Method: subjects tested in groups of about 20 members over 2 days for total time of about 9 hours. Criterion measures were peer ratings of pilot proficiency, officer-like qualities, and social acceptability; frequency of sick calls; and flight school data (N = 48) consisting of Aviation Qualifications Test scores, Flight Aptitude Rating (Mechanical Comprehension Test, Spatial Apperception Test, and a Biographical Inventory), and Final Flight Grades (composite of many performance ratings).

Results: On the basis of significant intercorrelations between personality and criterion measures, two shrunken multiple r's were computed. A multiple r of .430 was found between ratings of pilot proficiency and UI-16, -17, and -21 of the O-A battery and the K scale of the MMPI. A multiple r of .600 was found between Final Flight Grades and UI-20, -23, -25 of the O-A Battery, Pa, Ma, and F of the MMPI and T of the GTZS. Below are tabulated factors correlating significant at $p < .01$, .001 or twice at $p < .05$.

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Person. Measure	Pilot Prof.	Soc Accept	Sick Calls	Avia. Q Test	Flight Ap Ratg	Final Flight Grades
UI 16	-.394***		.566***	.370**		
UI 21	-.302**			.330*		
UI 22			.408**		-.294*	
UI 23						.353**
UI 26		.218*	-.273*		.358**	
Mf			.359**			
Pa		.264*				-.302*
Ma						.493***
F						-.341*
T						.367**

* p .05
** p .01
***p .001

Note: due to the comparative number of test variables and population size and sampling fluctuations, the author felt the multiple r's, even though shrunken, should be treated cautiously.

Detailed descriptions of what each of the personality scores represent are given. The appear below in abbreviated form:

GZTS FACTOR DESCRIPTIONS

G General Activity

High scores on this factor indicate strong drive, energy and a rapid pace of activities.

R Restraint

High scores indicate over-restraint, serious-mindedness and a high degree of self-control.

A Ascendance

Individuals who describe themselves as upholding their rights and defending themselves in face-to-face social contacts and appear to enjoy being conspicuous.

S Sociability

High scores on this factor indicate a high level of social partipation and the enjoyment of others' company.

E Emotional Stability

Individuals having an evenness of moods and interests, cheerfulness and optimism.

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O Objectivity

High scores indicate less egotism or not being self-centered and lack of hypersensitiveness and suspiciousness.

F Friendliness (Agreeableness)

A toleration of hostile actions, a lack of fighting tendencies, of an urge to please others and a desire to be liked are indicated.

T Thoughtfulness (Thinking Introversion)

High scores on this factor indicate a reflectiveness, a meditativeness with emphasis on the observation of other's behavior.

P Personal Relations (Cooperativeness)

High scores on this factor indicate an ability to "get along with others" and as being tolerant and understanding of others' weaknesses.

M Masculinity

High scores on this factor are indicative of masculinity of interests and activities, as being "hardboiled" and not easily disgusted or made fearful.

MMPI SCALE DESCRIPTION

Hs Hypochondriasis Scale

High Hs scores indicate abnormal concern about bodily functions and about health.

D Depression Scale

Poor emotional morale accompanied by feelings of uselessness and pessimism concerning the future are indicated. Evidence suggests that those responding to stress with depression are lacking in self-confidence, narrow in their interests, introverted, and have a tendency to worry.

Hy Hysteria Scale

Under stress the individual is apt to become overtly hysterical and to "adjust" to the situation by the development of symptoms.

Pd Psychopathic Deviate Scale

High Pd scores indicate a similarity to persons whose major difficulty is absence of deep emotional response, inability to profit from experience and disregard of social mores.

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Mf Interest Scale

High Mf scores in males indicate a tendency toward feminity of the interest pattern.

Pa Paranoia Scale

High Pa scores indicate a similarity to persons who are characterized by suspiciousness, oversensitivity and delusions of persecution.

Pt Psychasthenia Scale

High Pt scores indicate a similarity to persons troubled by compulsive behavior or phobias, as unreasonable fears and overreaction.

Sc Schizophrenia Scale

The subjective life is split from reality and it is difficult to rationally follow shifts in mood or behavior.

Ma Hypomania Scale

Individuals clinically high on this scale tend to get into trouble for undertaking too many things and are described as active and enthusiastic.

Si Social I. E. Scale

High Si scores indicate a tendency to withdraw from social contact with others.

L Lie Score

High L scores may indicate a tendency to falsify the inventory scores by choosing the "best", or most socially acceptable response.

F Validity Score

High F scores may indicate a lack of validity for the whole inventory.

K Score

High K scores are thought of as indicating a defensive test taking attitude and unconscious motives, may approach deliberate distortion toward presenting a more "normal" appearance.

O-A PERSONALITY TEST BATTERY - FACTOR DESCRIPTIONS

UI 16 Harric Assertiveness
Speed, poise, ideational decisiveness and self assertion form the esence of this factor.

II. C. Tests, Personality and Interaction Dimensions

UI 17 Inhibition

High scores on this factor, are indicative of caution, self-criticalness and timidity. It is held to be a measure of restriction of behavior or general inhibition.

UI 18 Hypomanic Smartness

Variables of ego weakness, conflict over the self and under estimation of the self serve to distinguish the compensative assertion effort found in this factor from the self assertion found in UI 16.

UI 19 Critical Practicality

High scores on this factor are indicative of conscientious exactness and criticalness, and reliability in a wide range of performances.

UI 20 Comention-Vs-Abcultio n

Dependence upon and a willingness to please an emotionally approved authority is emphasized in the interpretation of this factor.

UI 21 Exuberance

It represents a certain level of output, for any given intellectual level, which is present in individuals who succeed in a life of action.

UI 22 Corticalertia

High scores on this factor, which has also been referred to as "Nervous, Alert Reactivity," are indicative of high, nervous speed.

UI 23 Neural (Hypothaiamic) Reserves-vs-"Neuroticism"

High scores on this factor indicate an ability to mobilize resources to meet emergencies, a low inaccuracy rate compared to their speed of response and by little excess of aspiration level over performance level.

UI 24 Anxiety

High scores on this factor are indicative of high irritability, guilt, self-deprecation, emotionality of comment, uncertainty regarding new tasks and a desire to "do the right thing."

UI 25 Realism-vs-"Psychotic Tendency"

Individuals scoring high are described by low imaginative ability and accurate, desciplined computational performance.

UI 26 Self-Sentiment Control

High scores on this factor are indicative of steady, self-absorbed effective thinking coupled with self-awareness and self-control.

UI 27 Apathy (Apathetic Temperament)

High scores on this factor are indicative of apathy based on fatigue, depression or low morale.

279. Knoell, Dorothy M., and Stice, G. F. Development of attitude scales relevant to combat crew membership. Research Bulletin AFPTRC-TR-54-63, Air Force Personnel and Training Research Center, Lackland AFB, San Antonio, Texas. (AD 53 721)

ATTITUDE SCALES RELEVANT TO COMBAT CREW MEMBERSHIP

The authors comment that the "...scales exhibited satisfactory internal consistency...and were sufficiently independent to warrant their separate use in some analysis." (p. 16)

Description: 66 questions with 5-choice answers ranging from "strongly agree" to "strongly disagree". Scores are derived for the following sacles: confidence in Air Force management, sense of safety in flying, satisfaction with job assignment, liking for own crew, acceptance of Air Force goals and preference for aggressive action.

Note: this is apparently the scale used in reference no. 247.

280. Kohfeld, D. Some personality correlates of treadmill performance under public and private surveillance. Report No. 760, US Army Medical Research Lab., Fort Knox, Kentucky, November 1967. (AD 666 176)

PERFORMANCE AND PERSONALITY INTERACTION

Author's summary: "The role of subject factors in the expenditure of effort during treadmill exercise was tested by using a technique which gave the subject continuous control over his walking speed. It was found that subjects walked faster when an audience was present than when they performed privately. The individual differences in work output between the two experimental conditions were found to be related to scores on some scales of the California Psychological Inventory."

281. Kragh, U. The Defense Mechanism Test: a new method for diagnosis and personnel selection. Journal of Applied Psychology, 1960, 44 (5), 303-309.

DEFENSE MECHANISM TEST

Description: picture description and administration given in article. Tachistoscopic presentation of 2 pictures requiring 1 - 1½ hours; group administration. Subjects record descriptions and drawings of their observations. Well trained (14 day minimum) code raters needed.

Data: Test was used to predict whether Swedish aviation cadets and Danish attack divers would pass or fail training. Prediction on cadet groups, N = 70 to 146, made by one, two or three raters. Interrater reliability (mean) was .68. Range of rater validities ranged from $\dot{r}$ = -.05 to $\dot{r}$ = .66.

Measures: Pictures are such that the reactions "are interpreted in terms of precognitive "defensive" organization superimposed upon anxiety...Test was developed to test the assumption that "Frequent and strong activity of defense mechanisms is supposed to lower the individual's resistance against stress."

282. Krech, D., Crutchfield, R. S. and Ballachey, E. L. Individual in society. New York: McGraw-Hill, 1962, 507-522.

ASCH-TYPE and CRUTCHFIELD-TYPE GROUP SITUATIONS

Both the Asch and the Crutchfield methods are techniques for studying the conformity reaction of the individual to group pressure, particularly where the majority group judgment is erroneous with varying degrees of obviousness.

ASCH Method: the subject is placed in a group decision situation where the other members of the group are confederates of the experimenter.

CRUTCHFIELD Method: the subjects are seated in individual booths. The decision of other subjects re: the stimulus is presented by individual panel displays which are controlled by the experimenter.

283. Kugelmass, S. Reactions to stress. AF 61(052)839, AFOSR 67 0530. Dept. of Psychology, Hebrew University, Jerusalem, Israel, January 1, 1967. (AD 647 467)

WORRYING SCALE (WS), CALLED "TEST OF SOCIAL INTELLIGENCE"

Cost: Group administration, 30 minutes

Data: 36 psychology students received the WS 2 months prior to a stress experiment. Stresses included verbal threats and actual shock

while GSR and heart rate measurements were taken. 15 scores were derived from WS. Two types of GSR and heart rate measurements correlated well with the WS scores: Lability- .42 to .63 for 14 scores; Fear of Shock- .39 to .57 for 14 scores. A few of the other stress measurements correlated well with individual items. A correlation study with 40 students with The Taylor MAS and Edwards Social Desirability Scale produced no significant correlations which authors give as evidence of success in eliminating Social Desirability factor from the WS.

Description: Test content and administration given in article. A paper-pencil test containing both forced choice and verbal answer items. Called Test of Social Intelligence to try to eliminate faking. 15 scores including: social inhibitions, embarrassment, total social worrying, physical worrying, total intensity component, aggression, neutral, optimism, pessimism, rejection, reassurance, uneasiness, total C-score, D-dependent, D-independent, and D-total.

Measures: Intensity, pessimism, rigidity, personal history. These are considered to be necessary by the author to produce an anxiety scale.

284. Levitt, E. E. The psychology of anxiety. Indianapolis: Bobbs-Merrill, 1967.

STATE-TRAIT ANXIETY INVENTORY, STAI

Several anxiety tests are described in Chapter 5, The Experimental Measurement of Anxiety, including the STAI. The author evaluated the STAI as being one of the best anxiety test instruments reviewed from both theoretical and methodological standpoints. The test for trait anxiety is on one side of the test sheet, while the state anxiety test is on the other side. The tests represent the concepts that, "A measure of trait anxiety should be stable and consistent. A measure of state anxiety should be sensitive to stress situations. Trait scores ought to be correlated with increase in state scores under stress for a given group of respondents." (p. 72)

285. Lewinsohn, P. Some individual differences in physiological reactivity to stress. Journal of Comparative Physiological Psychology, 1956, 49, 271-277.

MMPI, TAYLOR MAS AND FAILURE STRESS

Subjects: VA patients, four groups of 16 subjects each which were judged free of psychotic syndromes: Group I, Controls with hemorrhoids, etc.; Group II. Anxiety with neuromuscular tension; Group III, Ulcers, Group IV. Hypertensions.

Method: Physiological measures: salivation, finger tremors, GSR and heart rate. Tests: first 365 items of the MMPI which includes the Taylor MAS. Stresses: Cold Pressor Test (CPT): immersion of feet in 4°C water. Failure Stress (FS): modified Digit Symbol test with shock and failure comments.

Results: CPT response very significant for finger tremors and GSR changes and significant at $p<.05$ for salivation change. FS response very significant for finger tremors and GSR and significant at $p<.01$ for heart rate. Finger tremor response to FS correlated with the Taylor MAS and the MMPI subscales of Hypochondriasis and Depression at $p<.05$. Heart rate response to CPT correlated with MMPI Hysteria and Taylor MAS at $p<.01$. Heart rate response to CPT correlated with MMPI Hypochondriasis, Depression and Psychosthenia at $p<.05$.

286. McCurdy, H. G., and Eber, H. W. Democratic vs. authoritarian: A further investigation of group problem-solving. Journal of Personality, 1953, 22, 258-269.

CALIFORNIA F SCALE

If the group is not strongly organized then homogeneous equalitarian groups make fewer errors in learning switch patterns than homo. authoritarian groups, significant at $p<.05$.

287. Mehrabian, A., and Reed, H. Some determinants of communication accuracy. Psychological Bulletin, 1968, 70, (5), 365-381.

THE DETERMINANTS OF COMMUNICATION ACCURACY

Communication accuracy is proposed to be a function of the attributes of the communicator, the addressee, the channel, the communication and the referent. The attributes of the communicator and the addressee are given as: cognitive complexity (determined by independence of judgment, verbal ability, authoritarianism lack, ambiguity tolerance and field independence), communicators' behavioral mode (gestures, etc.) and cognition mode, amount of deviation from the normal mode, degree and type of "set", interpersonal relationship, and the ratio of the processing rate to the processing capacity. The characteristics of the channel are the number available, rate and fidelity, and the accuracy of feedback. The attributes of communication were considered to be the occurrence of simultaneous and serial redundancy and it's objectivity. The referent was described by ambiguity and complexity parameters. The authors propose several hypotheses to relate the above attributes to the accuracy of communication and cite several studies, in each instance, which support the hypothesis.

II. C. Tests, Personality and Interaction Dimensions

288. Miller, J. G. The development of experimental stress-sensitive tests for predicting performance in military tasks. Technical Research Report PRB 1079, Contract DA-49-083 OSA-611 B-8-154, Adjutant General's Office, Dept. of the Army. Psychological Research Assoc., Washington 8, D.C.; October 1953. (AD 23 189).

STRESS SENSITIVE TESTS

Method: an initial battery of tests (Tachistoscopic: Broken Circles, Crictical Flicker Fusion (CFF), W-B Digit Symbol and Digit Span, Cancellation of C's, Tapping, Leg Swinging, PMA Word Fluency and Number, Myokinetic Lineogram, Luria, Auditory Flutter, Trembleometer, and Sentence Completion---all of these tests are well described in Appendix B) were administered to Air Force enlistees (N = 41 to 46) under both a non-stress condition and a stress condition, i.e., just prior to their first jump from the 34-foot jump tower used in training paratroopers. Four of these tests (Critical Flicker Fusion, Cancellation of C's, PMA Word Fluency and the Trembleometer) were then given to 500 civilian pre-inductees under non-stress conditions and stress conditions (white noise of 8000 cycles at 90 decibles). 125 subjects were tested twice under the non-stress condition, 125 subjects were tested twice under the stress condition, and 250 subjects were tested once under each condition.

Results: Initial test battery: Rhos between stress and non-stress test performances, and, where possible, t-tests or critical ratios between stress and non-stress performances were computed. The CFF yielded a rho of .43 and a critical ratio significant at $p < .001$. The W-B Digit Symbol rho was .51 and the t-test significant at $p < .001$, but was not included in the second test administration. Cancellation of C's had a rho of .75, but a critical ratio was significant at $p < .001$. The PMA Word Fluency test did not differentiate between the test conditions but the rho was only .35. The Trembleometer gave the lowest rho, .18, and differentiated between stress and non-stress significantly at $p < .05$. Scoring test battery: Rhos were calculated between the two test performances for each of the subsets of the 500 subjects population, i.e., stress 1-stress 2, nonstress 1-nonstress 2, and nonstress-stress. Only the Trembleometer appeared sensitive to the difference in test conditions with rhos of .435, .937, and .686, respectively. The CFF rhos indicated a possibility of sensitivity to stress conditions. CRITICAL FLICKER FUSION (CFF): Equipment includes an episcotister with a variable light-dark ratio, a calibrated speed motor, and a DC light of variable intensity; a head rest to maintain eye-target distance; night-vision goggles for dark-adaptation; and a motor masking noise presented through earphones. Procedural details given in article. TREMBLEOMETER: The equipment used here was developed by the British Army Operations Research Group. The subject's finger is inserted into a lock on the apparatus and the fine tremors are recorded by a sensitive "pen" that burns a hole in a metal-backed kymograph paper by an electric arc. There is almost no lag or friction effect. The test sessions consisted of 30 seconds of practice

and three minutes of recording. Further details are given in the article.

289. Moeller, G., and Applezweig, M. H. Manual for the Behavior Interpretation Inventory Form 59R. Technical Report No. 2, Project NR 172-228, Contract Nonr 996(02), Motivation Research Project for Group Psychology Branch, Office of Naval Research. Connecticut College, New London, Conn., November 1957. (AD 161 851)

BEHAVIOR INTERPRETATION INVENTORY

Cost: Group administration, 35-40 minutes. The Behavior Interpretation Inventory is Appendix A of this report but it is not included in copies of this report. It is available upon request from Dr. George Moeller, Human Factors Engineering Center, Naval Submarine Medical Center, New London, Groton, Connetticut.

Data: Norms based on men entering submarine school and the US Coast Guard Academy, and freshmen and sophomore college women. Test-retest reliability: ranges from .51 to .86. Validity studies indicate that self- and social-approval scales have construct validity but the other two are very questicnable.

Descriptions: 59 sentence stems with 4 choices each which must be ranked by the subject. The sentence stems describe 26 behavior modes.

Measures: Scores on four motives: escape from present pain or discomfort, avoidance of future pain or discomfort, social approval or belongingness, self-realization or self-approval.

Comment: the authors feel that a BII profile with 2 peaks suggests a motive conflicted person whose behavior would be more disrupted by a stress situation. This hypothesis is based on their theoretical approach to motivation and stress.

290. Mullins, C. J. Development of objective personality measures. In ONR Symposium Report ACR-60 Proceedings of the Tri-Service Conference on Selection Research at Pensacola, Florida, on May 25, 26, 27, 1960. Washington, D.C.: Office of Naval Research, Dept. of the Navy.

SELF-CONFIDENCE TESTS

Self-confidence is defined by the author as: "...the degree to which a person's willingness to take risks in a punishment-reward situation is influenced by his awareness that his own ability will affect the outcome...not...a risk-taking tendency." (p. 207) The following tests were suggested to measure self-confidence.

SELF-CREDITING-V (PL 8043): This test is in three 10-item parts (2 minutes per part) using a standard vocabulary test format. The examinee is given an ordinary vocabulary item example and told that he will soon be required to respond to ten more similar items. He is told that these ten items are usually easy for most people. The examinee then must turn his answer sheet over and write down how many points he is willing to risk on these ten easy items. He can risk any number of points from 1 to 5. He is told that for each right answer he will receive whatever number of points he bets, and for each wrong answer, the number of risked points will be subtracted from his score. After he has recorded his risk, he proceeds to take Part I. Then his answer sheet is picked up and another one passed out. He is told that the next ten items are "a little more difficult", and again he must note how many points he is willing to risk. Part III is the same except for the comment that it is "considerably more difficult". Both a verbal score and a self-confidence score, from the points risked by the examinee, are obtained. The author also uses the same test design for tests using spatial reasoning items, numerical reasoning items or general information items.

SPATIAL REASONING A (PL 8029): Spatial serial reasoning items with 5 alternative answers plus a sixth alternative if none of the five are correct. Half of the items do not have the correct alternative given. A count of the number of times the sixth alternative is chosen gives a self-confidence measure. A vocabulary test can be given the same way.

CAREFULNESS MEASURES

Carefulness is defined by the author as: "...the ability, or willingness, of a person to so confine his attention to the task at hand that will make a minimum number of mistakes over a comparatively long period of time... willingness to bear tedium in order to gain certainty." (p. 207) The following tests are proposed to measure carefulness.

SCORE CHECKING (PL 8016): Task consists of comparing 275 pairs of numbers and marking the discrepancies.

COUNTING ACCURACY (PL 7134): Task is the counting of dots in a series of squares.

BROKEN PATTERN-(BE 461 AX-2): Examinee must compare an incomplete pattern with a complete one, and mark in whatever is missing.

LETTER COMPARISON (PL 0011): Task is to compare a group of random letters on the left side of the page with another group on the right side of the page, and to mark under "Y", for "Yes", if the groups are exactly alike. If the groups are different in anyway, the subject is to mark under "N", for "No".

II. C. Tests, Personality and Interaction Dimensions

291. Olmsted, D. W. and Monachesi, E. D. MMPI trends of small group leaders and members. Tech. Report No. 4, Contract No. N8 ONR 66216. Minneapolis, Minnesota: University of Minnesota, 1955. (AD 70972)

THE MMPI AND LEADERS AND MEMBERS DIFFERENCES

Procedure: MMPI was administered to formal leaders and members of 39 college student groups of two functional types: task and no-task groups. The MMPI was also administered to the fire captains and firemen of 40 groups.

Results: Leaders vs. members in task groups: leaders had significantly high Psychasthenia ($p<.01$), Depression ($p<.01$), Masculinity-($p<.02$) Femininity and Schizophrenia ($p<.05$) scores in student task groups. In firemen groups the captains had higher Hypochondriasis ($p<.005$), Hysteria ($p<.05$), Depression ($p<.025$) and Psychasthenia ($p<.025$) scores. No-task groups, leaders vs. members: leaders had lower paranoia ($p<.02$). No-task leaders vs. task leaders: task leaders had higher Depression ($p<.05$) and higher psychasthenia ($p<.01$). No-task members vs. task members: no-task members had higher Depression ($p<.02$).

292. Peterson, F. E., Lane, N. E. and Kennedy, R. S. The relationship of the Edwards Personal Preference Schedule to success in naval flight training. Report No. NAMI-946, MF022.01-5001.1-46, Naval Aerospace Medical Institute, Pensacola, Florida, October 1965. (AD 627-011)

EDWARDS PERSONAL PREFERENCE SCHEDULE AND TRAINING SUCCESS

Method: The EPPS was evaluated as a predictor of success or failure in naval flight training.

Results: The EPPS failed to discriminate between student aviators who successfully completed training and those who either dropped or failed.

293. Porter, L. W., and Ghiselli, E. E. The self-perceptions of top and middle management personnel. Personnel Psychology, 1957, 10, 397-406.

DMA TEST

Subjects: 270 persons. 100 top management including presidents, vice-presidents, and directors of regional operations or heads of large plants. 170 middle management including operating division and department heads (but not men who directly supervised line workers), personnel and industrial relations managers, purchasing agents, analysts, and engineers.

Data: Authors used the 64 item Self Description Inventory. Of these, 21 differentiated between the two levels of management at $p<.05$ or better (specifics not given). (Note: these 21 items assumed the name, DMA scale, at a later date).

Description: 21 item forced choice adjective checklist. On 11 items, the subject is required to check the adjective which he feels best describes him. On 10 items, the subject is required to check the adjective which he feels least describes him. The two adjectives given for each choice item were felt by the authors to be roughly equated for social desirability, as: sympathetic vs. patient. It is the Decision Making Approach scale extracted from Self Description Inventory.

Measures: The self perceptions of the subject, i.e., the personal traits which the subject believes that he possesses. The differential choices of top and middle management led the authors to describe the self perceptions briefly as follows: top management-the "dynamic brains" and innovators; middle management-the "backbone" with a careful thoroughness.

294. Porter, L. W. and Kaufman, R. A. Relationships between a top-middle management self-description scale and behavior in a group situation. Journal of Applied Psychology, 1959, 43, 345-348.

DECISION MAKING APPROACH (DMA) scale

If the task offers alternative solutions and requires flexibility rather then adherence to only one method, then the DMA is not predictive of performance.

295. Postley, J. A. Report on a study of behavioral factors in information systems. National Science Foundation contract NSF C265. Hughes Dynamics, Inc., Advanced Information Systems Dept., Los Angeles, California. (Ad 418 630)

ORGANIZATION COMPATIBILITY, FIRO-F TEST

A functional analysis is proposed to determine the compatibility requirements of an organization. The importance of compatibility to organization member interactions is determined by consideration of the amount of interaction between member pairs and the importance of the interaction to the furthering of organizational aims. The basis of the derived weighted measurements if the FIRO-F test. A sample analysis of an organization is given and the assignment of weights to the measurements is demonstrated. A copy of the FIRO-F test is given in Appendix B.

II. C. Tests, Personality and Interaction Dimensions

296. Reed, S. C. Some relationships between conceptual complexity and mental abilities. RB-66-33, Office of Naval Research Contracts Nonr 1858-(15) and Nonr 2214 (00) and US Public Health Service Research Grant 1 P01 HD 01762-01. Educational Testing Service, Princeton, New Jersey, June 1966. (AD 489 593).

SENTENCE COMPLETION TEST (CALLED PARAGRAPH COMPLETION TEST)

Subjects: 189 high school students

Method: The students were given the Sentence Completion Test (SCT) twice to measure Conceptual Complexity along with a test battery which measured: "g" factor, expressional fluency, flexibility of closure, and selectiveness of attention (field independence). The results were factor analyzed, the performance of the high and low complexity students compared, and a multiple regression analysis done on SCT performance.

Results: Difficulties occured with respect to the SCT data; a limited range of low level performance and small reliabilities of .24 and .55, using an internal consistency method and the test-retest procedure. The hypothesis that high and low complexity subjects would have different ability organizations was not supported. The factor analysis identified a separate factor marked by the SCT. The multiple regression analysis indicated that the best predictors of performance on the first administration of the SCT were tests of general reasoning and the Progressive Matrices Test. The Simile Interpretation Test, the Utility Test and the general reasoning tests were the best predictors of performance on the second administration of the SCT.

297. Rock, M. L. and Hay, E. N. Investigation of the use of tests as a predictor of leadership and group effectiveness in a job evaluation situation. Journal of Social Psychology, 1953, 38, 109-119.

THE TAT AND LEADER-MEMBER SEPARATION

Group: 7 preselected subjects - best for committee position from the available personnel.

Data: Group is twice as effective if leaders are leaders and members are members.

Method: TAT cards 2, 13, 4, 14, 7, and one other used. Leader-member traits of subjects predicted from interview, Personnel Test data, and observer ratings of group interaction on TAT story composition. Subjects had composed stories to TAT cards prior to the group composition. Effectiveness measure was derived from number of jobs evaluated by subjects as a group. 7 scores were obtained as each subject functioned as leader for a $2\frac{1}{2}$ hour trial.

298. Rokeach, M. The open and closed mind. New York: Basic Books, 1960.

DOGMA SCALE

Measures: "...individual differences in openness or closedness of belief systems...should also serve to measure general authoritarianism and general intolerance." (p. 72)

Description: 40 item paper and pencil test in which degree of agreement with the item is indicated. The test and its instructions are given on pp. 72-80.

Data: Reliability: 508 subjects were tested including groups of first year psychology students, English workers and American institionalized (VA) veterans. The reliabilities, odd-even corrected by Spearman-Brown formula, ranged from .68 to .93. Norms: Means and standard deviations for each of the above groups are given. Validity: Two studies were run where the subjects were judged to be high or low dogmatic and then administered a test battery. Study I: 29 students which were judged by the faculty as high (13 Ss) or low (16 Ss) dogmatic. No difference was found between the groups on any of these tests: Dogma Scale, Opinionation Scale, Calif F Scale, Ethnocentrism Scale. Study II: Graduate psychology students selected peers judged by them to be hi or low dogmatic and hi or low opinionated. (N = 20, 10 hi, 10 low; 6M, 4F and 4M, 6F) All of the peers were outside the psychology field. Most were students, a few were not. The difference between the scores of the highs and lows on the Dogma Scale were significant at the .01 level. Further, the California F Scale scores were also particularly significant at the .01 level.

GOUGH-SANFORD RIGIDITY SCALE

Description: 22 item paper and pencil test reproduced in Appendix C of Rokeach's book. It makes up part of the California Psychological Inventory where it is labeled F_x (Flexibility).

Measures: flexibility vs. rigidity

299. Schutz, W. C. Studies in group behavior. I. Construction of high productivity groups. ONR Contract No. N-onr-494(03), Project No. NR 145, 1953. (AD 21514)

GROUP COMPATIBILITY TEST AND AGRESSION TEST

Purpose: tests were used by author to construct compatible and incompatible groups

Measures: Group compatibility test: designed to measure four dimensions (15 test items each): (1) Pairing: desire for personal relationships, (2) Counterpairing: avoidance of personal relationships, (3) Dependency: approval of particular authority symbols, as, how problem

has been solved by others, (4) Counterdependency: disapproval of these authority symbols. Aggression test: contains 16 items to measure agression and 16 items to measure withdrawal.

Description: Total of 60 items on compatibility test and 32 items on aggression test administered as a forced-choice card-sort as used in Q-technique. This report includes complete copies of both test in the appendix. The authors commented (p. 24) "With regard to the compatibility test the results were certainly encouraging but the test leaves much to be desired. The interpretation of the test was too intuitive and not sufficiently communicable. Work is now in progress to convert the test into a series of Guttman-type scales, utilizing H-technique."

EXPERIMENTAL STUDY USING THE GROUP COMPATIBILITY TEST

Subjects: eight 5-member groups of Navy enlistees who had recently completed basis training. Groups matched on mean and range of IQ.

Method: Compatible and incompatible groups formed by selection of focal persons and appropriate members on the basis of their compatibility test responses and inferrals thereof. The tasks consisted of: (1) Intercept Problem: required some agreement among members for every decision made, (2) Plotting Problem: division-of-labor cooperation required with physical interaction, (3) Coding and Identification Problem: minimal cooperation and interaction required, highly intellectual, (4) Valuative Problem-opposing value discussion; no quantitative data taken. Each group received 2 to 5 runs of increasing difficulty per task; the Intercept Problem was a competitive situation.

Results: The prediction of comparable group productivity were confirmed as follows: Intercept Problem: Compatible groups performed better than noncompatibles, $p < .035$. Plotting Problem: Compatible groups performed better than noncompatibles, $p < .03$. Coding and Identification Problem: No significant difference, as predicted. Post-hoc leadership predictions were 82% correct.

300. Schutz, W. C. Group Behavior Studies: II: relation of sociometric choices to personality patterns. Report No. 1954-494-03-16, Navy Contract No. N-onr-494(03). Tufts College, Medford, Mass., February 1954. (AD 63488)

GROUP COMPATIBILITY TEST AND SOCIOMETRIC CHOISES

Note: this report deals with further data from experimentation noted in 1953 report.

Hypothesis: "After several meetings the leadership structure of compatible groups will be clearer to its members than the structure of incompatible groups will be to its members." (p. 14)

Results: "The compatible groups tend to have more agreement regarding who is the leader, even if he isn't actually functioning as the leader (coordinator). The difference between the proportion of men in the compatible groups who agree that the coordinators are actually the leaders and the proportion of men in the in the incompatible groups who so agree is significant beyond the .01 level. This result would indicate that the compatible groups had clearer and more accurate notions of who their leaders were than did the incompatible groups." (p. 15)

301. Schutz, W. C. FIRO: A three dimensional theory of interpersonal behavior. New York: Holt, 1958.

Reprint edition: Schutz, W. C. The interpersonal underworld. Palo Alto, California: Science and Behavior Books, 1966.

FIRO-B

Test and scoring given on pp. 61-65

Data: Reliability: One week test-retest on 57 students and one month test-retest on 125 to 183 students ranged from .71 to .82, mean = .76. Author states that since FIRO-B consists of Guttman scales, split-half reliability and content validity are built in.

Measures: inclusion, control and affection as predictors of interaction for instrumental task groups (especially, leadership and compatibility). The measures relate to the personal-counterpersonal dimension and homogeneous groups of either type perform better then heterogeneous groups.

302. Schroder, H. M. and Streufert, S. The measurement of four systems of personality structure varying in level of abstractness (Sentence Completion Method). Technical Report No. 11, Office of Naval Research Group Psychology Branch Contract NONR 1858 (12), Project NR 171-055. Princeton University, November 1962. (AD 288 257)

SENTENCE COMPLETION METHOD

Description: 8 sentence stems which are completed by the subjects. The sentence stems and the necessary manuals for scoring the stems along a concrete-abstract dimension and a schema complexity dimension of the authors' personality theory are included in the article. A discussion of the theory is also given.

303. Shure, G. H. and Rogers, M. S. Note of caution on the factor analysis of the MMPI. Psychological Bulletin, 1965, 63, 14-18.

MMPI AND FACTOR ANALYSIS

The authors factor analyzed the MMPI interscale common-element correlations produced by item overlap. They found that the two or three factors extracted were very similar to the factors produced by other studies using overlapping scales but that these same factors were not produced by factor analysis of truncated scales (i.e., overlapping items removed). On this basis, the authors found the use of the MMPI factors derived from analysis of overlapping scales to be questionable.

304. Smith, P. B. Differentiation between sociometric rankings. Human Relations, 1963, 16, 335-350.

ATTRACTION TO GROUP (ATG) TEST

Author states that previous work with this test and others of group cohesiveness indicates that this individual test is a better measure of cohesiveness.

305. Spielberger, C. D., Gorsuch, R. L., and Lushene, R. E. The State-Trait Anxiety Inventory (STAI), Preliminary Test manual for Form X. Tallahassee, Florida: Dr. C. D. Spielberger, Dept. of Psychology, Florida State University, 1968. Also available from Consulting Psychologists Press, 577 College Avenue, Palo Alto, California.

STATE-TRAIT ANXIETY INVENTORY

Description: the State and the Trait anxiety tests are 20 questions each, requiring 6 to 8 minutes per test. The test items are those retained from test development procedures using a pool of items from the IPAT Anxiety Scale, the Taylor Manifest Anxiety Scale, and the Welsh Anxiety Scale.

Data: Norms are given for high school juniors, incoming college freshmen, and undergraduate college students. Reliability: 104 day test-retest reliabilities are: A-Trait .73 to .77, A-State .31 to .33.

306. Steiner, H. M. and Peters, S. C. Conformity and the A-B-X model. Journal of Personality, 1958, 26, 243-258.

II. C. Tests, Personality and Interaction Dimensions.

ASo AND CONFORMITY

Procedure: Pairs (one naive and one "plant") were required to respond to questions individually in the presence of each other. The "plant" always preceded the naive subject and responded with a preset series of answers (half popular and half unpopular). Conformity score was derived from a comparison of the agreement/disagreement responses. Prior to the experiment, subjects rated themselves and good and poor co-workers on the ASo inventory. Following experiment, the subject rated his partner on the same scale. Indices of subjects devaluation of his partner and tendency to over or underestimate disagreements were obtained from his responses to questionnaire items concerning the "importance of making accurate judgments" and number of disagreements remembered.

Results: Nonconformers rated their partners lower than themselves on ASo inventory. The discrepancy between the nonconformers' ratings of best- and least-liked partners (ASo test) was greater than that of the conformers. Also the nonconformers underestimated their disagreements over trials more than conformers. No differences were noted in tendencies to devaluate their partner and there was no relationship between degree of discrepancy between ratings of good and poor coworkers and the tendency to assign lower trait ratings to the "plant" partner than themselves.

307. Stock, Dorothy and Thelen, H. A. Emotional Dynamics and Group Culture. Washington, D.C.: National Training Laboratories, Div. Adult Educ. Serv., National Education Assn of the US. New York University Press, 1958.

REACTIONS TO GROUP SITUATIONS TEST (RGST)

Description: 44 sentence completion items. The sentences are evaluated for pairing, fight, dependency, and flight situations that appear in the sentence completions.

Measures: the strength of "valence" with respect to the affective approach of the individual to the group, cultural preference and areas of concern.

308. Streufert, S. and Driver, M. J. Impression Formation as a measure of the complexity of conceptual structure. Technical Report No. 5, ONR contract N00014-67-A-0115-0002. Douglass College - Rutgers, The State University, September 1967. (AD 659 962)

IMPRESSION FORMATION TEST

The report presents an overview of recent studies using the Sentence Completion Test and the Impression Formation Test. U-curves are presented

for information processing performance under varying information loads for complex vs. simple subjects using both tests. The Impression Formation Test is presented with scoring guidelines.

Data: five week test-retest reliabilities range from .72 to .92 for the five sets of adjectives.

Description: the subject is given a specified time (1½-3 minutes) to describe a person to whom a set of three adjectives would apply. Five sets of adjectives are used.

Measures: perceptual social complexity.

309. Taylor, Janet E. A personality scale of manifest anxiety. Journal of Abnormal and Social Psychology, 1953, 48, 285-290.

TAYLOR MANIFEST ANXIETY SCALE (TAYLOR MAS)

Description: 50 discriminative items with modifications given in the article. Administered with 225 nondiscriminative items. Paper-pencil, group administered, items mainly extracted from MMPI.

Data: Norms: based on 1971 students, 683 basic AF trainees and 201 night school students. Reliability: three week test-retest: .89 Pearson product moment correlation. Five month test-retest: .82 Pearson product moment correlation. 9-17 month test-retest: .81 Pearson product moment correlation. Validity: As of 1953, validation against psychotics had not been done. Had been used primarily as a research device for classifying subjects.

310. Teevan, R. C., and Dapra, R. A. Fear of failure and indices of leadership utilized in the training of ROTC cadets. Technical Report no. 26, Contract Nonr 3591(01), NR 171-803, Group Psychology Branch, Office of Naval Research, Bucknell University, Lewisburg, Pennsylvania, April 1968. (AD 668 823)

LEADERSHIP OPINION QUESTIONNAIRE, TAT

Subjects: 43 ROTC college seniors.

Tests: Leadership Opinion Questionnaire, the TAT scored for fear of failure motivation by the Hostile Press System, and evaluations from the ROTC summer camp on leadership, job performance, peer rating and military proficiency.

Results: Fear of Failure correlated with the Structure score from the Leadership Opinion Questionnaire at -.348 and with the Initiative rating at -.293, both significant at $p < .05$.

The authors felt that these results indicated that individuals scoring high on Fear of Failure do not structure their own roles nor their subordinates roles toward goal attainment.

311. Titus, H. A. and Hollander, E. P. California F scale in psychological research 1950-1955. Psychological Bulletin, 1957, 54, 47-64.

CALIF F SCALE

A review of the research during 1950-1955 using the California F Scale reveals that the F Scale correlates best with other paper and pencil tests. It correlates poorest, i.e., the least systematically, with interpersonal behavior.

312. Torrance, E. P. Crew performance in a test situation as a predictor of field and combat performance. HFORL Report No. 33, Human Factors Oper. Res. Lab., Bolling AFB, Washington, D.C., March 1953. (AD 14473)

PROBLEM SOLVING TEST (401-B, (HFORL), GROUP-INTERACTION PICTURE-STORY TEST (MICHIGAN GROUP PROJECTION SKETCHES), AND GROUP SQUARES TEST

Summary: The problem solving test, picture-story test and the individual and group rating procedures significantly differentiated between good and poor group performances. Which measures were predictive depended on the groups being considered, i.e.: "good" vs. "poor" groups by instructor ratings in survival training, drop-out vs. "poor" vs. "better" combat groups (2-4 months in the Korean War) by superior office ratings, and "effective" vs. "ineffective" groups rated by bombing missions failed.

Subjects: Were students at the SAC Survival School. The number of crews considered in each study was as follows: Survival training: 20 good vs. 20 poor; Combat crews rated by superior officers: 20 drop-out, 20 "poorer", and 20 "better"; Combat crews rated by bombing missions failed: 16 effective vs. 17 ineffective (only crews having 5 or more missions were considered.)

Description of tests: The test sources, administration, the observer rating blanks used, and the scoring procedures are given in the article. Group administration time is 50 minutes. Problem Solving test: 8 problems are presented each with 15 related facts. The group must decide which are the most important facts for each problem. Scores and performance ratings obtained. Group Interaction Picture Story Test: both group and individual scores are obtained. Test consists of 2 pictures of which the first was the most useful. The first is a formal conference, the second is a more informal conference picture. Both individual and group stories are made up for both pictures.

II. C. Tests, Personality and Interaction Dimensions

Group Squares Test: An adaptation from Bavelas. Eleven $3\frac{1}{2}$"x$3\frac{1}{2}$" squares are variously cut into 3 pieces and numbered. The score is the group time needed to construct all squares.

Results: The t-ratio was used to test the difference between individual and group scores. Survival Training crews (good vs. poor): $p<.01$ for 5 test performance ratings and score on 401-B test. $p<.01$ for 4 individual scores on 1st picture. $P<.01$ for 3 group scores on first picture. $P<.01$ for 1 individual score on 2nd picture. $P<.05$ for 2 individual scores on 2nd picture. Combat crews (dropouts, poorers and betters): $p<.01$ on 5 performance ratings for dropouts vs. betters. $P<.01$ on all group and individual scores on 1st picture for better vs. poorers. $P<.01$ on all 4 individual scores on 1st picture for better vs. dropouts. $P<.01$ for 2 group scores and $p<.05$ for 2 scores on 1st picture for better vs. dropouts. $P<.01$ for 3 individual scores on 2nd picture for betters vs. poorers. $P<.01$ for 2 individual scores and $p<.05$ for 4 individual scores on 2nd picture for better vs. dropouts. Combat crews (effective vs. ineffective: performance ratings one at $p<.01$, one at $p<.05$, one at $p<.10$. First picture 4 individual scores and 1 group score at $p<.10$. Second picture 1 individual score at $p<.01$, 1 individual score at $p<.05$, 1 group score at $p<.10$.

Measures: Problem-solving test and Group-Interaction Picture-Story Test were considered to be primarily verbal-intellectual tasks. The Group Squares Test was hoped to measure a "doing things with one's hands leadership' factor." The Group Performance Measures included: utilization of manpower, participation, coordination, control, flexibility. Perceptual measures on 1st picture included: satisfactory outcomes, someone leaving group, orderly functioning, and productive group. Perceptual measures on 2nd picture included: harmony, disagreement, neutral, family group, friendship group, organizational or occupational group, status differences, degree of hedonistic pleasure and degree of similarity to crew story.

313. Townsend, J. C. and Smith, W. J. Predicting decision making behavior from personality and cognitive variables. Tech. Doc. Report ESD-TDR-64-619, Project 9678, Task 967802, Contract No. AF 19(628)-2822, Decision Sciences Lab., Electronic Systems Div., AF Systems Command, USAF, L. G. Hanscom Field, Bedford, Mass., November 1964. (AD 610 521)

DECISION MAKING BEHAVIOR

Subjects: College males and females in a variety of classes. Pilot study in one university (N = 60), final study in another university (N = 201).

Method: Decision making criterion was the Townsend Smith Test of Decision Making Ability which yields Goodness of Decision, Decision Time and Confidence scores on each of three conditions: risk, cer-

tainty and uncertainty. This is a paper and pencil test from which total scores are also derived. The cognitive and personality variables were measured by: California Personality Inventory, 16 Personality Factor Test (Form C), SCAT, Henmon-Nelson Test of Mental Ability (Form A), California Test of Personality and the Watson-Glaser Critical Thinking Appraisal.

Results: Authors note that although many of the correlations are highly significant, they are not high enough to be very useful in a population of intelligent, normal persons in a non-stress situation. The authors suggest that prediction of decision-making from personality variables would be especially useful in stress situations. Good results were obtained from the pilot study. A priori multiple regression equations resulted in uncorrected R's ranging from .37 to .66 for all of the decision variables. Neither the SCAT nor the Watson-Glaser test correlated with the decision test scores and were therefore dropped from the main study. In the main study the R's from the a priori multiple regression equations based on the first study ranged from .15 to .39. Six of the decision scores were predicted by one or two equations at the.01 level of significance. Six more of the decision scores were predicted by one or two equations at the .05 level. The equations and the criterion score means and standard deviations are given in the article.

Description: Test covers the risk, uncertainty and certainty areas of decision making, scores are obtained on goodness of decision, decision time, and confidence for each of the three areas and for the total performance. Risk subtest: betting situations where the best decision is that bet which maximizes the probability of a net gain based on the probability of winning, value of bet and the expected payoff. Answers are scored as good, fair or foolish. Uncertainty: Choosing among alternatives when their probability of success is not known. A 49 item test using usual life situations which might commonly require a decision. Certainty subtest: defined as where the choice relates directly to a particular goal. Test items presented situations in which a person is in conflict with western value systems. Subject must state what the person should have done and what he would have done in the situation. Highest score given when the should and the would are in accordance with each other and with the common value system.

Source: apparently only available from the authors.

314. Tuckman, B. W. Personality structure, group composition and group functioning. Sociometry, 1964, 27, 469-487. (Also available as AD 296227)

II. C. Tests, Personality and Interaction Dimensions

SENTENCE COMPLETION AND SITUATIONAL INTERPRETATION TEST - PREDICTION OF GROUP BEHAVIOR

Subjects' personality structure was classified according to Harvey's system into 4 groups, Systems I through IV, which are differentiated by integrative complexity and capabilities for abstractness. Subjects were classified on basis of responses to the following tests: Sentence Completion Test, Situational Interpretation Test, Calif F Scale, Dogmatism Scale, Rigidity Scale, Machiavellia Scale, and the Ascendance-Submission Scale. 36 of the graduate students tested were selected such that there were 9 which fit each System well. These were divided such that there were 12 homogeneous matched groups, 3 in each System category.

Task was the SOBIG stock market game performed for ten $1\frac{1}{2}$ hour sessions. Analysis was performed on the observer ratings of the middle six performers. 5 out of 6 interpersonal behavior and 5 out of 7 task performance predictions of group rankings were significant at p .01.

Significant predictions were: abstractness of group structure, abstractness of decision mechanisms, autocracy of leadership, task-relevant cooperation, information seeking, market activity, ability to forecast, sales index tracking, over-all tracking. Extent of leadership was significant at $p < .10$.

SENTENCE COMPLETION TEST

Projective test in which the individual is asked to respond to 11 sentence fragments or stems. These stems are of three varieties: (1) those which can imply the presence of alternatives; (2) those which can imply the imposition of external standards; and (3) those which can imply interpersonal conflict. Stems are then scored for personality system structure and content.

SITUATIONAL INTERPRETATION TEST

Test consists of 36 pairs of statements, each representing an ideal response to interpersonal criticism for one of the four personality systems specified by Harvey. Subjects must choose one member of each pair, yielding scores in all four systems.

315. Tyler, F. T. A factor analysis of fifteen MMPI scales. Journal of Consulting Psychology, 1951, 15, 451-456.

MMPI FACTORS (SCALE ANALYSIS)

Factors found (107 college female subjects):
1. General maladjustment
2. Conflict

3. Social agression and friction
4. Socially adjusted, self-confident, strong drives
5. "Feminity"

316. Voas, R. B., Bair, J. T. and Ambler, R. K. Relationship between behavior in a stress situation and later separation from flight training with expressed anxiety toward flying. Psychological Reports, 1956, 2, 393-397.

STRESS AND PERFORMANCE

Subjects: 1540 flying cadets.

Method: One of the pre-flight training procedures is a pressure chamber experience during which cadet behavior is observed. The chamber is depressurized to a 20,000 ft. altitude, the cadets remove their masks for 10 minutes, and then replace them for the descent. The cadets are told to replace their masks earlier if they suffer ill effects and to request a slower descent if they suffer ear blocks. Exhibition of one or both of these behaviors was recorded; it was felt that some percentage of these occurances would be the result of anxiety effects. The cadets who dropped out of flight training due to poor flying performance or dislike of flying underwent a consultation. The consultation data was reviewed for evidence of expression of anxiety about flying.

Results: Of the 1320 cadets who successfully completed training, 1 out of 3 displayed chamber anxiety. Of the cadets who entered flight training and dropped, 46 expressed anxiety over flying. Of the 46, 2 out 4 displayed chamber anxiety (p .01). The rest of the dropouts either dropped prior to flight training or did not express anxiety with respect to flying - of these, the percentage of cadets who displayed chamber anxiety was also approximately 1 out of 3.

317. Vroom, V. H. Some personality determinants of the effects of participation. Journal of Abnormal and Social Psychology, 1959, 59, 322-327.

CALIFORNIA F SCALE, NEED FOR INDEPENDENCE, AND SUPERVISOR JOB PERFORMANCE

Method: Supervisors were administered questionnaires measuring perception of participation in decision making, job attitudes, needs for independence and authoritarianism. Their performance was rated by observers acquainted with their work. Two performance scores were derived: over-all performance rating and ability to meet job demands rating.

Results: Generally, neither need for independence nor degree of authoritarianism, considered alone related to job performance. However, supervisor feelings of participation in decision making did relate to

over-all performance and to ability to meet job demands when subjects were pooled with respect to their authoritarianism and independence scores. The subjects who felt they participated more in activities and also had moderate and high independence scores were generally more rated as being more able to meet the job demands.

318. Welsh, G. S. Factor dimensions A and R. In G. S. Welsh and W. G. Dahlstrom (Eds.) Basic readings on the MMPI in psychology and medicine. Minneapolis, Minnesota: University of Minnesota Press, 1956, 264-281.

MMPI, FACTORS DERIVED FROM TRUNCATED SCALES

Description: A factor analytic study was performed (N = 150 VA hospital patients) using the MMPI scales and some non-overlapping scales which had been developed. The unrotated centroid factor loadings on the scales indicated that the non-overlapping scale A loaded .99 on factor I and non-overlapping scale R loaded .88 on factor II. A third factor loaded on the overlapping scales but not on the truncated scales. Scale A consists of 39 items from the MMPI, while Scale R utilizes 40 items. The items and the proper scoring is given in the article.

Measures: Factors A and R seemed generally related to anxiety and repression, respectively. The author grouped the items of A and R into content clusters. The content clusters for Factor A were given as: thinking processes, negative emotional tone and dysphoria, lack of energy and pessimism, personal sensitivity, and malignant mentation (only 3 items). Factor R's content clusters were: health and physical symptoms; emotionality, violence and activity; social interactions; social dominance, feelings of personal adequacy and personal appearance; personal and vocational interests.

Data: some norms are given.

319. Welsh, G. S. and Dahlstrom, W. G. Basic readings on the MMPI in psychology and medicine. Minneapolis: University of Minnesota Press, 1956.

MMPI

A reference work covering the MMPI.

320. Weybrew, B. B. The Personal Inventory Barometer (PIB): II. Obverse factor analysis with PIB items as a validation technique with submarine school criteria. US Naval Medical Research Lab. Report No. 309, Project

NM 23 02 20 .01 .02, Bureau of Med. and Surgery, Navy Department, Submarine Base, New London, Conn., May 6, 1959. (AD 232985)

PERSONAL INVENTORY BAROMETER (PIB)

Summary: Obverse factor analysis was used to identify the trait patterns characteristic of successful and unsuccessful submariner volunteers (20 Ss). Analysis on the PIB yielded 4 types of unsuccessful and 1 type of successful enlisted volunteer and, within these types (322 Ss), differential predictability of the Navy Arithmetic-Mechanical Aptitude Test.

Subjects: The 20 subjects who had scored above the 70th percentile on the PIB included 6 successes and 14 failures with respect to a criterion of pass or fail in Submarine School. The 322 subjects comprised a class in Submarine School.

Description: 52 anxiety syndrome oriented items from the PIB and 48 filler items for self description using a 10 point scale. Group administration. Source of PIB given in article.

Results: Test-retest (6 week) reliability is .80 (154 Ss). Corrected split-half reliability is .94 (360 Ss). 36% of the coefficients in the interpersonal correlation matrix are significant at the 5% level but the mean Pearson coefficient is .23. Six factors were found but only five had large enough loadings on individual Subjects to identify the factor. The loadings used for identification ran from .46 to .84. Three scoring keys were developed and the factor scores of the 281 successes and 41 failures were compared. Factor 1 differentiated with all 3 keys at $p < .005$, $< .005$ and $< .001$. Factor 5 differentiated with 2 keys at $p < .04$ and $p < .01$. Factors 1 and 5 are identified as follows: Factor 1: nervous, impatient, worrier, hot tempered, easily bored, poor appetite and daydreamer. Factor 5: chronically anxious, troublesome obsessive thoughts, sympathy seeker, feels "picked on", and noticeable hand tremor.

Correlations of the Arithmetic plus Mechanical scores with the "good" and the "poor" fits to each of the five factors indicated differential predictability from the aptitude test. Within a group of Submarine volunteers who fit the "failure" class, the aptitude predictive validity is significantly lower than for those who fit the failure class less well. And the aptitude predictor validity within the group fitting the success "type" was higher than was found for the group failing to fit the success type.

321. Weybrew, B. B. Prediction of adjustment to prolonged submergence aboard a Fleet Ballistic Missile Submarine. IV. Psychophysiological Indices. Bureau of Med. and Surgery, Navy Department, Research Project MR005.14-2200-1.06, US Naval Medical Research Laboratory Report No. 416, Submar-

ine Base, New London, Conn., November 24, 1964. (AD 449530)

ADJUSTMENT TO CONFINEMENT PREDICTED

Subjects: Two crews of men on a Fleet Ballistic Missile Submarine (submerged 40 days or more). Total sample sizes ranged from 125 to 160.

Method: Tests: General Classification Test (GCT), a verbal test of IQ; PIB, and the Self-reported Motivational Questionnaire (SMQ), "tapping" attitudes towards Navy and submarine service. Criterion: sum of ratings which had previously been found to relate to the 2 most significant factors re: favorable adjustment. Factor 1 content description: favorable performance, adequately motivated, attitudes improve during rehabilitation, favorable attitudes towards Navy, self confident, likable, high leadership ability, emotionally stable, adaptable to change, favorable attitudes toward FBM, somewhat agressive, and rated as adaptable. Factor II: not excitable, not tense, not anxious, adaptable to chg, likeable, emotionally stable, favorable FBM attitudes, self-confident, favorable Navy attitudes, rated high as a submariner, highly motivated. GSR measurements: were repeatedly made during two experimental conditions and 11 scores derived from there. First experiment: subject hyperventilated with 3 deep breaths and then held the 4th as long as possible. BHT refers to time, in seconds, 4th breath was held. Second experiment: following 'ready' signal 2 lights and a loud buzzer came on simultaneously. Subject depressed button, turning off lights and buzzer, when he had decided which light was the brighter. Subject then stated which light was the brighter. There were 5 practice trials and 16 experimental trials with decreasing intensity differences. The intensities were set at the difference limen on the 8th trial, and were equal on the last 4 trials. The significant performance measurement here was the mean discrimination time during the first 8 trials, called DT.

Results: Rotation of the intercorrelations resulted in five factors. The factors and their variable loadings are as follows:

Factor I (Limited Adjustment Potential):	Stress-GSR range .882 to .932
	BHT-GSR range .185 to .513
	Factor II -.187
Factor II (Optimal Adjustment Potential):	Stress-GSR range -.212
	BHT-GSR range -.257 to .218
	Factor I .889
	Factor II .972
	GCT score .213
	PIB score -.186
Factor III (Autonomic Recoverability):	Stress-GSR range .924
	BHT-GSR range .819 to .247
Factor IV (Autonomic Feedback):	BHT-GSR range -.399 to .432
	DT -.390
	GCT .378

Factor V (Stress Responsibility): Stress-GSR range -.188
SMQ .267
BHT-GSR range .230 to .829

322. Weybrew, B. B. Selection of men for hazardous duty from indices of individual differences in autonomic nervous system reactivity. Memorandum report 65-1, MR005.14-2100-1.13, US Naval Submarine Medical Center, US Naval Submarine Base New London, Groton, Connecticut, February 1965. (AD 624 783)

ANS MEASURES AND RATINGS

Article discusses two studies and presents a brief review of others where ANS measures have been taken. Palmar Electronermal Conductance measures, percent change and percent recovery in an experimental stress situation correlated significantly with several ratings.

Study 1: 20 submariner candidates were rated by two instructors on 22 trait scales. Percent recovery correlated at $p<.01$ on: emotional tone (tendency to blush) and emotional stability and correlated at $p<.05$ on: self-concern, adaptability to change, likeability, and mood.

Study 2: 40 submariner volunteers were rated by peers on 5 trait scales. Percent recovery and percent change both correlated at $p<.05$ with: likeability, tenseness, overall submariner potentiality. Percept change correlated at $p<.05$ with emotional stability. None of the ANC measures correlated significantly with a motivation rating.

323. Weybrew, B. B. and Youniss, R. P. The Personal Inventory Barometer (PIB): I. Development of the questionnaire. Bureau of Med. and Surgery, Navy Dept., Project NM 23 02 20.1.1, US Naval Medical Research Laboratory Report No. 290, August 22, 1957. (AD 217 104)

PERSONAL INVENTORY BAROMETER (PIB)

Description: 100 item test using a 9-point scale for self-description. 52 of the items are scored including 31 unrevised and 4 revised items from the Taylor MAS. The complete test is included in the report.

Data: Norms on 508 students (enlisted men in Submarine School) and on 96 officers are given. Test-retest (5 week) reliability on 169 students was .80. Validity: PIB designed to identify poor psychiatric risks within the volunteer group reporting for Submarine School. The t-ratio between the mean scores of the dropouts (85 Ss) and the Graduates (405 Ss) was significant at $p<.03$ but there was not an ideal cut-off score.

Doubt expressed whether a good criterion for validity was used since dropouts included academic failures, temperamental reasons, emotional instability, and escape tank failures.

Measures: manifest anxiety.

324. Williams, S. B. and Leavitt, H. J. Group opinion as a predictor of military leadership. Journal of Consulting Psychology, 1947, 11, 283-291.

LEADERSHIP AND SOCIOMETRIC MEASURES

Procedure: OCS candidates were given a series of tests and rating instruments during training, including a personality and biographical questionnaire and a questionnaire for rating fellow classmates on desirability as roommates, ability as combat officers, as leaders, etc. Scores on these measures were related to indices of performance effectiveness, based on follow-up ratings by superiors of combat proficiency, and to success in OCS.

Results: Group member evaluations of other member characteristics as a leader, roommate, sense of humor, etc., were highly intercorrelated with each other and with indices of combat proficiency and success in OCS.

All other ratings of individual member characteristics, such as those by instructor and platoon officer, judgments and self-ratings, and objective scores on tests of general intelligence, mechanical ability, etc., were not significantly related to each other or to the final criteria of combat proficiency and success in OCS.

II. D. Tests, Vision

325. Duntley, S. Q., Austin, R. W., Harris, J. L. and Taylor, J. H. Experiments on visual acuity and the visibility of markings on the ground in long-duration earth-orbital space flight. NASA Contractor Report 1134, Contract No. NAS 9-5095, Manned Spacecraft Center, NASA, Washington, D.C. University of California, San Diego, California, November, 1968.

VISUAL ACUITY, ASTRONAUTS

The activities responsible for the Gemini experiments on visual acuity and the experimental data are presented in detail. Also complete construction details are given on the equipment used including the Inflight Vision Tester.

326. Duntley, S. Q., Austin, R. W., Taylor, J. H., and Harris, J. L. Experiment S-8/D-13, Visual acuity and astronaut visibility. In Gemini Midprogram Conference February 23-25, 1966, at the Manned Spacecraft Center, Houston, Texas. Washington, D. C.: National Aeronautics and Space Administration. NASA SP-121.

VISUAL ACUITY, ASTRONAUTS

Equipment: Inflight Vision Tester which tested the threshold of orientation discrimination. A pattern compatible to the one used in the Inflight Vision Tester was prepared on the ground for astronaut observation.

Method: The astronauts were tested on the Inflight Vision Tester several times prior to and during flight. Similar bar patterns with a discrimination of difficulty range were used during both flights the only difference being the addition of large, high contrast markers to aid in location on the Gemini VII flight. The experiments were performed during the Gemini V and VII flights which lasted for 8 and 14 days respectively. Both were two-man flights.

Results: The pre-, in-, and postflight tests on the Inflight Vision Tester indicated no significant change in visual capability. Although only one observation was made from Gemini V of the ground pattern the bars observed were within the statistical range of his preflight visual performance on a simulated visual discrimination task. Three observations were possible on Gemini VII and again the performance was precisely in accordance with the astronaut's preflight visual thresholds.

327. Erickson, R. A. Relation between visual search time and peripheral visual acuity, Human Factors, 1964, 6(2), 165-179.

PERIPHERAL VISUAL ACUITY

Subjects: 16 males, aged 23 to 41 years with differing foveal acuities.

Method: The peripheral acuity apparatus and procedure are described in detail. Essentially, a Landolt C ring is exposed for 1.5 sec. at a time in various positions. The time needed to find a target by visual search was provided by displays or rings or blobs, one of which would have a gap or a projection to be found by the subject.

Results: Peripheral acuity measured at 3.6° and 4.8° off the visual axis correlated significantly at $p < .01$ with time needed to find the target in displays containing 16 or 32 rings and correlated at $p < .05$ with search time needed on displays of 16 and 32 blobs. Almost all correlations involving search times from object densities of 48 and/or acuity measurements made at 6° off the visual axis were not significant. There were no significant intercorrelations between observer age, foveal acuity as measured in a naval eye examination, and peripheral acuity. Furthermore, age and foveal acuity did not correlate significantly with search performance.

328. Faucett, R. E., and Newman, P. P. Operation Hideout; preliminary report. Medical Research Lab. Report No. 228, Vol XLL, no. 13, Project NM 002015. 10.02, Bureau of Medicine and Surgery, Navy Dept., July 3, 1953. (AD 65 201.)

EFFECTS OF LONG TERM CONFINEMENT AND 1.5% CO_2

Summary "In order to determine the effects of prolonged exposure to 1.5 per cent carbon dioxide, twenty-three human volunteers were placed aboard a partially activated fleet type submarine for a period of two months and were exposed to that percentage of carbon dioxide during six weeks of this period. Prior to, during, and after the exposure, period, measurements of physiological functions and psychomotor performance were made....Measurements of psychomotor performance, including simple motor responses, sensory discrimination, complex motor coordination, and alertness, revealed no significant decrement in these functions."

(ex abstract, p. ii). In general, the performance changes were as would be expected from learning. The tests which indicated a possible decrement, as noted below, were a stereo-acuity test, a tracing test, and an addition test. The N per test ranged from 5 to 20.

TESTS AND EFFECT ON PERFORMANCE (OTHER THAN LEARNING):

Bio-Photometer (night vision): none

Baush and Lomb Ortho-Rater (visual acuity, depth perception, and phorias): only lateral phoria was affected with a few individuals tending toward esophoria. No group trend was noted.

Phorometer (amplitude of accommodation): none

Baush and Lomb Stereoscopic Trainer M-2 (stereo acuity): the type of performance change and time of occurance within the two-month period seemed to indicate an interaction with emotional and social factors rather than CO_2 concentration.

Navy Sonar Pitch Memory Test (pitch discrimination): none

MAICO Clinical Audiometer (auditory acuity, i.e., threshold for pure tones): apparently none. Interpretation of data was unclear due to variations in testing chamber noise level.

Minnesota Manual Dexterity Test (aiming, wrist-finger speed, spatial factors): a steady, gradual performance decline occurred only on the Tracing sub-test. Performance generally improved on the other sub-tests.

Steadiness and Aiming Tests (arm-hand steadiness and aiming; stylus and board with holes used): none

Hand Dynamometer (strength and motivation scores): none. (However, it was noted that the fluctuations in the motivation score tended to reflect the self-reports).

Two-Hand Complex Tapping Test: none

Yerkes Multiple Choice Problem (frustration): none

Immediate memory span (5 numbers or letters used): none

Addition Test (a speed test): a steady improvement occurred throughout the six-week CO_2 period. Of interest was the positive acceleration in improvement that occurred when fresh air was restored.

329. Jampolsky, A., Morris, A., and Collins, C. In M. A. Whitcomb and Wm. Benson (Eds) Vision Research: Flying and Space Travel, Proceedings of Spring Meeting, 1964. Washington, D. C.: National Academy of Sciences-National Research Council, 1968. (AD 669 266)

II. D. Tests, Vision

STATIC VS DYNAMIC VISUAL TESTS

"Static visual tests do not adequately reflect operational needs" (p. 16) i.e., dynamic tests are needed. For example, glare recovery, dynamic visual acuity, and tolerances to various types of stress are not related to perfection of the static visual parameters.

330. Johnston, Dorothy M. Search performance as a function of peripheral acuity. Human Factors, 1965, 7 (No. 6), 527-536.

PERIPHERAL ACUITY

Subjects: 36 male engineers

Method: five types of measurements were made: visual static acuity (American Optical Sight/Screener), visual field (American Optical Brombach Perimeter; complete details given in the article), perceptual speed (Air Force Speed of Identification Test, CP 610 C), and two search tasks with three display sizes each (one was a series of military equipment silhouettes and the other was a series of C ring silhouettes--the object was to find the one silhouette which was different with respect to one detail).

Results: Visual search performance was shown to be a function of peripheral acuity, or visual field size, by analysis of variance, significant at $p < .01$. Peripheral acuity correlated with search performance* and with visual acuity, sig at $p < .01$ ($r = -.5$).

* The size of the correlation of visual field size was related to the size of the display:

Military silhouettes:		C.Ring silhouettes:	
r = -.06	small display	r = -.28	small display
r = -.22	medium display	r = -.30	medium display
r = -.31	large display	r = -.48	large display

331. Ludvigh, E. and Miller, J. W. A study of dynamic visual acuity. Joint Project Report No. 1, Contract Nonr-586(00), Project Designation No. NR-142-023, Project No. NM 001075.01.01, Kresege Eye Institute Project, U. S. Naval School of Aviation Medicine, Naval Air Station, Pensacola, Florida, March 4, 1953. (AD 15173)

DYNAMIC VISUAL ACUITY

Subjects: 18 male subjects, ranging in age from 17 to 33 years. Static visual acuity, as measured by Snellen test letters, ranged from 20/15 to 20/20 uncorrected.

Method: Dynamic visual acuity was measured using Landolt rings, subtending from .75 to 11.25 minutes of arc at the nodal point of the tested eye, and a revolving mirror. The mirror allowed .4 seconds viewing time of the ring with angular velocities ranging from 10° to 170° per second. A complete description of the test situation is given in the article.

Results: The results indicate that dynamic visual acuity cannot be predicted from static visual acuity. At 110°/second the mean threshold values (arc minutes) ranged from 3.04 to 11.925. Some of the subjects were unable to locate the break in the largest ring at the 140°/second velocity. Of the five subjects who successfully discriminated ring breaks at 170°, one gave the worst performance at 20°/second and the other four subjects gave performances at 20°/second which were comparable with four who were unable to discriminate at 170°/second.

332. Luria, S. M., and Weissman, S. Relationship between static and dynamic stereo acuity. Report No. 516, Bureau of Medicine and Surgery, Navy Dept. Research Work Unit MF022.01.04-9004.07, U. S. Naval Submarine Medical Center, Submarine Base, Groton, Conn., March 15, 1968. (AD 671 579).

STATIC AND DYNAMIC STEREO ACUITY, OR DEPTH PERCEPTION

Subjects: 50 males, civilian and military

Method: A Howard-Dohlman device was used which could be rotated about the subject's head. Two rods, one fixed and one variable positioned were used. A variable viewing slit was used to control the viewing time. Four speeds of rotation were used: 60, 90, 120 and 180 degrees/second.

II. D. Tests, Vision

333. Miller, J. W. The measurement of dynamic visual acuity while the observer is rotating. Joint Project NM 001 110 501, Report No. 11, Kresge Eye Institute and U. S. Naval School of Aviation Medicine, Pensacola, Fla., September 10, 1956.

DYNAMIC VISUAL ACUITY

Data from this study (6 subjects) compared with a study (18 subjects) wherein the subject was stationary and a rotating mirror device was used and with several other studies using other test devices. The results from all the test methods were in general accordance.

Measures: foveal visual acuity during ocular pursuit which is apparently"...dependent chiefly upon the efficiency of integration of the entire oculomotor system..." (p. 1)

Test description: subjects were rotated in a modified link trainer which could be rotated in a horizontal plane at speeds ranging from zero to 26 revolutions per minute. The position of the subject's head was fixed. The stationary targets were Landolt rings ranging in size from .972 to 25.989 minutes of arc at the nodal point of the tested eye. The subject was required to judge the position of the break in the ring twice before progressing to the next smaller ring. Subject threshold was determined.

Results: Visual acuity deteriorated rapidly from 1.69 arc minutes at a 20^0 per second velocity to 10.00 arc minutes at 120^0 per second velocity. "Previous studies have demonstrated that individuals with substantually the same static acuity may differ markedly and significantly in their dynamic acuity...The visual acuity of subject one is seen here to relatively unaffected by increases in angular velocity until a speed of 120^0/sec. is attained whereas that of subject two, although slightly superior to subject one at an angular velocity of 20^0/sec., shows a marked reduction with successive increments in the angular velocity of the test object...higher angular velocities where individual differences were found to be more pronounced." (p. 7)

334. Miller, J. W. and Ludvigh, E. The results of testing the dynamic visual acuity of 1000 naval aviation cadets. Joint Project NM 001 110 501, report no. 10, Kresge Eye Institute and U.S. Naval School of Aviation Medicine, Pensacola, Florida, August 10, 1956. (AD 119 606)

DYNAMIC VISUAL ACUITY

The dynamic visual acuity of 1000 naval aviation cadets at the angular velocities of 20°/second and 110°/second were tested. The method reported in Ludvigh and Miller was used. The results and some data analysis are presented. It was found possible to place individuals into statistically distinguishable groups on the basis of their dynamic visual acuity.

335. Pigg, L. D. Gross visual acuity. In Lois R. Hammer (Ed). Aeronautical systems division studies in weightlessness: 1959-1960. WADD Tech Report 60-715, Aeronautical Systems Div., AF Systems Command, USAF, Wright-Patterson AFB, Ohio, December 1961. (AD 273 098)

STATIC VISUAL ACUITY AND WEIGHTLESSNESS

Subjects: N=36.

Method: Subjects were tested on the Armed Forces Vision Tester and the Snellen Test for binocular and monocular near and far vision under the following environmental conditions: straight-and-level flight on the C-131 and during zero-G flight on the C-131, and on the ground.

Results: The loss of acuity was less under zero-G then had been found previously under positive acceleration but greater then the decrement under 1-G level flight. Both t-tests and nonparamentic tests indicated significant differences between the three conditions at the .05 level or better. The author concluded that "...visual acuity as measured is decrementally affected by short-term exposure to weightlessness in the aircraft, although the loss is probably too small to be handicapping." (p. 33)

336. Uhlaner, J. E. and Zeidner, J. The Army Night Seeing Tester - development and use. Human Factors Research Branch Tech. Research Report 1120, Army Project No. 2195-60-001, May 1969. (AD 258 349)

ARMY NIGHT SEEING TESTER (ANST)

The authors conducted a number of experiments over a period of years using a number of different kinds of targets under night viewing conditions. The data was factor analyzed and two factors were found which accounted for "...about 80 percent of individual variation in night seeing effectiveness." (p. 7) The two factors are brightness contrast discrimination and fine detail resolution.

ANST description: the Brightness Contrast Test consists of successive rows of chevrons presented at a precisely calibrated light level. The examinee is required to identify the position of each chevron. The test targets vary from high to low in density while the background is held constant. Each plate presents a different pattern of chevron positions. The Resolution test is measured by a series of lines of equal contrast value. The lines gradually diminish in width. The lines in the squares vary in thickness by row, whereas length of line and background brightness are held constant. The line positions are varied.

"Soldiers with high or better-than-average ANST scores in general perform more effectively in night field problems than do soldiers scoring low on the tests." (p. 20) Specifications for the ANST-II, scoring procedures, and a brief review of visual research concerning night vision are presented.

337. White, W. J. The effects of transient weightlessness on brightness discrimination. Tech. Documentary Report No. AMRL-TDR-64-12, Contract no. AF 33(657)-11600, Behavioral Science Lab., Aerospace Med. Res. Lab., Aerospace Med. Div., AF Systems Command, Wright-Patterson AFB, Ohio, March 1964. (AD 435 544).

BRIGHTNESS DISCRIMINATION AND WEIGHTLESSNESS

Subjects: 6 men, aged 20 to 28 years with 20/20 vision.

Method: an apparatus developed by Braunstein and White was used. The subjects were tested while semisupine and visually adapted; binocular vision was used. The same subjects were used both in the 10-15 second weightless condition and in the 1G control condition. The background luminance levels were .03, .28, and 30.0 foot-lamberts. 14 to 20 trials per subject per condition were obtained.

II. D. Tests, Vision

Results: Slightly less contrast was needed under the weightless condition for all three levels of luminance (significant at $p < .005$). The rankings of the subjects' performance under the luminance levels and the gravity conditions were fairly consistent. Of interest, however, is the range of mean performances across the individual subjects under the three luminance levels.

	Mean Percept Contrast Required	
ft-lamberts	0G	1G
.03	12.56%	15.14%
.28	6.4%	7.05%
30.0	3.99%	4.45%
	Range of Contrasts Required for Discrimination	
.03	10.88 - 14.60%	11.76 - 18.86%
.28	5.82 - 7.34%	5.98 - 8.19%
30.0	3.85 - 4.27%	3.95 - 4.82%

338. Wienke, R. E. Absolute judgments of light intensity. AMRL-TR-64-103, Behavioral Sciences Laboratory, Aerospace Medical Research Laboratories, Aerospace Medical Division, AF Systems Command, Wright-Patterson AFB, Ohio, October 1964. (AD 609 050)

LIGHT INTENSITY APPARATUS, DISCRIMINATION BY ABSOLUTE JUDGMENTS

Subjects: 12 male college students, 20/20 vision.

Method: Apparatus is completely described in the article. A projector system is used. Five light intensities (stellar magnitudes of 2.30, 2.89, 3.76, 4.43, and 5.33) were termed one through five for the subjects in two presentations prior to the trials. Each subject completed ten series of 20 absolute judgments each. The responses were correlated against the stimulus using the Pearson product-moment method.

Results: the correlations per subject ranged from .59 to .88, indicating intersubject differences.

II. E. Tests, Miscellaneous Dimensions

339. Ambler, Rosalie K., and Guedry, F. E., Jr. The validity of a brief vestibular disorientation test in screening pilot trainees. USN Aerospace Medical Institute Report 122, October 1965.

A brief vestibular disorientation test (BVDT) has been developed that involves an assessment of reactions produced by head movements in a rotating chair. Both high validity and reliability are demonstrated for pilot trainee separation and airsick sensitivity.

340. Benson, A. J., and Reason, J. T. Individual differences in after-effects of apparent motion. Part II: Judgements of exponentially decaying signals, impulsiveness, and motion sickness susceptibility. Flying Personnel Research Committee Memo 226 (b), Air Force Department, Ministry of Defense, London, England, April 1966. (AD 828 654)

MOTION SICKNESS SUSCEPTIBILITY

Summary: Previous research had indicated to the authors that wide and reliable individual differences existed in persistance of visual and labyrinthine after-effects of motion. A second-order measure, a slope score, was found to both correlate significantly with motion sickness and to be intrapersonally stable measure across modalities.

Subjects: 48 male Royal Air Force apprentices.

Test administered:
SPIRAL AFTER-EFFECT: an illuminated rotating (100 rpm) Exner spiral placed 5 feet from the subject. Four block randomized presentations each of four periods of rotation (15, 30, 60, and 120 secs.) were judged by the subjects. The subjects were asked to indicate when they "thought" they could no longer detect the after-sensation. Time was measured to the nearest .5 secs.
Labyrinthine after-effect: both sensation (when subject "thought" rotation had stopped) and nystagmus cupulograms were derived. The subject was seated on a turntable with velocity and braking controls.
Exponentially decaying sinusoidal oscillator (EDSO): A 860 cps tone dacayed in intensity exponentially, with a 16 second time constant, into a white noise background. Subject pushed switch when he could no longer distinguish the tone. Four intensity values were used.

VIDSO, a visual EDSO: A brighter patch of light on a background of uniform illumination decayed in brightness exponentially. Each subject made four judgements of when he could no longer detect the patch of light.
Expanded judgment task: a series of 200 cards with red spots (signals) and blue spots (noise). The subject stopped turning the cards over one at a time when he decided no more red spots would appear. Four packs of 200 cards were used for each subject. Each pack had the same signal decay rate but differed with respect to the starting number of signals.
Impulsiveness-Cautiousness Questionnaire: a 34 item questionnaire which is given in Appendix A.
Maudsley Personality Inventory (MPI)
Motion Sickness Questionnaire: a biographical questionnaire given in Appendix B.
Scores: total judgement time, stimulus threshold, and slope. The slope score represented the steepness of slope relating signal stimulus level to reported duration of signal given by its time-constant in seconds. The Spiral, Labyrinthine, EDSO and VIDSO tests were considered to require sensory decisions, while the Expanded Judgment Task was considered to require cognitive decision-making.

Results: The sensory measures were all intercorrelated significantly; five at $p<.01$ and one at $p<.05$. The authors felt this implied consistent individual differences in the judgment process, regardless of the sensory modality. The Impulsiveness-Cautiousness Questionnaire did not approach significant correlation with any other measure. The Extraversion Scale of the MPI correlated at $<.001$ with the Impulsiveness-Cautiousness Questionnaire only. The implication of this was felt to be that these tests are not useful predictors of sensory or cognitive decision-making. Analysis indicated that stability existed intrapersonally between the slope scores but not between the sensory thresholds. Motion sickness correlated .427 with the Spiral After-effect slope and .376 with the Spiral threshold (sig at $p<.01$). It did not correlate significantly with any other measures.

341. Buros, O. K. (Ed.) The Sixth Mental Measurements Yearbook. Highland Park: N. J.: Gryphon Press, 1965.

II. E. Tests, Miscellaneous Dimensions

SEASHORE MEASURES OF MUSICAL TALENTS, REVISED EDITION

Ages: grades 4-16 and adults

Cost: $12 per set of record, 50 IBM answer sheets, scoring key, and manual; $2.30 per 50 IBM answer sheets; 60¢ per set of manual and scoring key. Group administration; 60 minutes.

Data: norms are available on grades 4-16. Kuder-Richardson 21 reliabilities range from .64 for the time test to .84 for the pitch test.

Description: Subjects listen to a record and mark their choices on an answer sheet. Six scores are obtained: pitch discrimination, loudness discrimination, rhythm discrimination, time discrimination, timbre discrimination. Apparently phonograph limitations are such that only the lower partials are well represented.

AUDITORY AND VISION

The sources for some vision and audition discrimination tests are given in the Vision and Hearing sections.

342. Fleishman, E. A., Roberts, M. M., and Friedman, M. P. A factor analysis of aptitude and proficiency measures in radio-telegraphy. Journal of Applied Psychology, 1958, 42, 129-135.

AUDITORY FACTORS

Subjects: 310 airmen entering radio operator training.

Method: factor analysis was applied to 14 tests (5 auditory tests, taped, and 9 printed tests) and a criterion measure. The criterion was the number of classroom days required to attain a code (Morse) receiving speed of 14 groups per minute.

Results: Five factors were found and defined as follows: Visualization, Verbal Ability, Auditory Rhythm Perception, Speed of Closure, and Auditory Perceptual Speed. The primary factors found to contribute to performance on the proficiency criterion were: Auditory Rhythm Perception, Speed of Closure, and Auditory Perception Speed with factor loadings of .31, .44, and .31, respectively.

II. E. Tests, Miscellaneous Dimensions

RHYTHM DISCRIMINATION (FORM D): This was the authors fourth revision of an adaptation of the rhythm subtest of the Seashore Measures of Musical Talent. The subject hears a series of 70 pairs of rhythm patterns (beats within each pair presented in rapid succession). After each pair he must mark, on an IBM answer sheet, under the S if the patterns in each pair are the same, under the D if they are different, and under the (?) if he cannot decide.

DOT PERCEPTION TEST (FORM C): This was the authors' third revision of this test. The examinee hears a series of code signal groups, consisting of rapid patterns of "dots" and "dashes". Each signal group is about the same total length in terms of time, but the internal arrangement of the "dots" and "dashes" varies from item to item. The "dots", however, always come in a single series, at the end of beginning of the signal group. For each group of items the S simply marks (on an IBM answer sheet) the number of "dots" presented (from 1 to 5) within each group. The speed of transmission increases at intervals through the test. 160 items.

MUTILATED WORDS: Each item presents a word with parts of each letter missing. The subject writes out the full word in the adjacent space. (see concealed words test)

COPYING BEHIND: The subject hears groups of numbers called out in rapid succession, as 4-2-1-5-3. His task is to mark under the proper number, in turn, on an IBM answer sheet, attempting to keep up with the pace set by the narrator. The pace increases at intervals through the test. 240 items.

Hidden Tunes: (This test was obtained by the authors from Edward L. Walker and Benjamin White. The reference given is: White, B. W. Visual and auditory closure. J. exp Psychol, 1954, 48, 234-240.) The subject hears a series of short tunes presented in pairs. The second tune is always longer than the first in each pair, and the subject must determine if the second tune included the first. For each pair he marks under either yes or no on his answer sheet. 50 items.

Army Radio Code Test: The test is designed to measure the speed with which the subject can learn certain actual Morse Code signals (for I, N, and T). Approximately 25 minutes of the test involves the practice, with knowledge of results, of these signals under increasingly higher rates of speed. For the test period the subject marks under the I, N, or T on an IBM answer sheet as each signal is presented in rapid succession. 150 test items.

II. E. Tests, Miscellaneous Dimensions

TEST	Visual-ization	Audit Rhythm	Spd of Closure	Audit Perceptual Speed
Rhythm Discrimination		.56		
Dot Perception		.58	.28	.32
Copying Behind		.32	.31	.54
Hidden Tunes	.28	.62		
Army Radio Code		.30		.51
*Concealed Figures	.66			.31
Marking Accuracy	.32			.28
Mutilated Words	.38		.55	

*See Hidden Figures Test - it is an adaptation of the Concealed Figures test.

343. Graybiel, A., Clark, B., and Zarriello, J. J. Observations on human subjects living in a slow rotation room for periods of two days: canal sickness. AMA Archives of Neurology, 1960, 3, 55.

CORIOLIS ACCELERATION ILLUSIONS

The two day confinement in the Pensacola slow rotation room demonstrated that a marked degree of adaptation is possible for some individuals.

344. Lewis, S. T. A spatial disorientation demonstrator. USAF School of Aerospace Medicine, Aerospace Medical Division (AFSC), Brooks AFB, Texas, March 1965. (AD 461 347)

USAF SAM SPATIAL DISORIENTATION DEMONSTRATOR

Description: A cab, simulating a single-seat aircraft and containing stick and rudder pedals and an attitude control indicator, is mounted on a circular platform which can be rotated 360° about the vertical axis at speeds of 0 to 10 rpm and simultaneously or separately on the longitudinal and lateral axes. At the same time the cab and platform can be rotated on a circular tract at 15 rpm.

Measures: This device simulates aircraft maneuvers and the Coriolis effect which produces spatial disorientation. Although designed originally for a training aid and demonstrator, the subject's performance

with the controls and attitude control indicator should give a measure of susceptibility to spatial disorientation and the Coriolis effect. According to this report, the necessary modifications to convert the demonstrator into a research tool for which standards of performance can be established have been undertaken.

345. Mitchell, Mildred B. Time disorientation and estimation in isolation. Tech. Documentary Report No. ASD-TDR-62-277, Electronic Tech. Lab., Aeronautical Systems Division, Air Force Systems Command, Wright-Patterson AFB, Ohio, April 1962. (AD 277 148)

TIME DISORIENTATION IN ISOLATION

Subjects: 33 males and 1 female including 10 Dyna-Soar test pilots. Median age - 30 years; median IQ - 125; 25 had college degrees.

Method: Subjects were isolated in a 13x6x7 foot anechoic chamber and were monitored by a GSR recording and a microphone. All subjects made time estimates during a two hour period as follows: a button was depressed for 1 second every 6 minutes, except at 30 minutes when they pushed the button for 5 seconds and at 60 minutes when they pushed it for 10 seconds to indicate the end of the hour. For 18 of the subjects the experiment was extended. Ten of the subjects were given an electric clock and continued to estimate time in the same manner as above for four hours longer. Eight of the subjects continued in the isolation chamber for 48 hours (except 2 subjects who terminated earlier) without a clock or lights. These subjects indicated 4 and 8 o'clock by depressing a button for 1 second, noon by depressing it for 5 seconds, and midnight by depressing it for 10 seconds.

Results: The 1 second interval was overestimated, 5 seconds was judged accurately, and 10 seconds tended to be underestimated. Six minutes, 30 minutes, 60 minutes, and 120 minutes were significantly underestimated ($R<.001$, .001, .001, and .001) (8.3, 41.1, 82.2, and 164.4 minutes). There were large individual differences. The range of the estimated 120 minutes was from 93 to 318 minutes, while eight of the subjects were accurate within 15 minutes. The 6 minute estimates ranged from less than 1 minute to 44 minutes. Some of the subjects became quite confused as to the proper signal or the relative time, but not all of the subjects were disturbed by this. The subjects who judged the 2 hour interval more accurately also scored higher on the order scale of the Edwards Personal Preference Schedule ($p<.001$) and all of the eight more accurate subjects persisted in some scheme for estimating time (as counting to 60).

II. E. Tests, Miscellaneous Dimensions

346. Rees, D. W., and Copeland, Nola K. Discrimination of differences in mass of weightless objects. WADD Tech Report 60-601, Behavioral Sciences Lab., Aerospace Medical Division, Wright Air Development Division, Wright-Patterson AFB, Ohio, December 1960. (AD 252 161)

MASS DISCRIMINATION TEST

"Absence of gravity results in the loss of many familiar kinesthetic cues of weight and friction necessary to man for object discrimination and manipulation. Man's ability to discriminate small differences in mass as opposed to small differences in weight was studied. Four weight series were used, each consisting of a standard (1000, 3000, 5000 or 7000 grams) and nine comparison stimuli. Judgments for mass differences were made with the same weights supported by compressed air on an air-bearing table. Thus, the frictionless aspect of a weightless environment was simulated.

Results show that the mean difference limen, mean standard deviation, and Weber ratio (S/S) for each standard are much larger for mass than for weight. Thus, to be detected under a weightless condition, mass increments must be at least twice as large as the weight increments required for discrimination in a normal weight-lifting situation." (p iii)

The Weber ratio for the control weight condition of the experiment was close to .05 for all four weights, which is considered to be most accurate weight discrimination. For the weightless condition, however, the Weber ratio was .16 for the 1000 gram mass and approximate .10 for the other masses.

347. Sidowski, J. B. (Ed.) Experimental Methods and Instrumentation in Psychology. New York: McGraw-Hill, 1966.

AUDITORY AND VISION TESTS

The text includes a chapter on audition and a chapter on vision. The information given includes the construction and sources of apparatus and the methods of measurement. Under audition, these areas are covered: sensitivity thresholds, discriminations (single or bandwidth frequency, intensity, duration, harmonic composition, location and phonemic), interference, and pattern perception. Under vision, sensitivity (photopic, scotopic and spectral) and discrimination (signal separation, intensity and spectral) are discussed.

II. E. Tests, Miscellaneous Dimensions

348. Simonds, J. S. "VITA" time estimation apparatus: control data on 10 normal volunteers. U. S. Army: Edgewood Arsenal EATM 114-9, July 1967.

The variable interval time analyzer (VITA) provides a time estimation task. Administered to 10 subjects, in 60 trials, over a five-day period, the task appears to have internal stability and reliability. No validity information is available.

II. F. Performance Panels

349. Adams, O. S., and Chiles, W. D. Human performance as a function of the work-rest cycle. WADD Technical Report 60-248, Contract No. AF 33(616)-6050, March, 1960. (AD 240 654)

PERFORMANCE PANEL PERFORMANCE AND WORK-REST CYCLES

Abstract quote:

"This study was designed to investigate the effect on performance of four different work-rest period schedules (2 on and 2 off, 4 on and 4 off, 6 on and 6 off, and 8 on and 8 off) followed over a period of 96 hours. The subject sample consisted of 16 male college students with 4 subjects being assigned to each of the four work-rest period schedules. Performance was measured by means of a battery of psychomotor tasks involving arithmetic computation, pattern discrimination, monitoring, and vigilance. Additional data were obtained from information recorded in an experimenter's logbook and from responses to a subject questionnaire administered at the end of testing.

Although the performance tasks failed to differentiate among the four experimental groups, the observational evidence suggested that the subjects in the 2-hour and 4-hour groups achieved a more favorable adjustment than those in the other two groups."

350. Adams, O. S. and Chiles, W. D. Human Performance as a function of the work-rest ratio during prolonged confinement. Tech. Report 61-720, Contract nos. AF 33(616)-6050 and AF 33(616)-7607, Behavioral Science Lab., Aerospace Med. Lab., Aeronautical Systems Div., USAF, Wright-Patterson AFB, Ohio, November 1961.

PERFORMANCE PANEL ON A 4-2 WORK-REST RATIO DURING 15 DAY CONFINEMENT

Subjects: Two B-52 combat crews, 5 men recalled from leave aged 26 to 43 years and 6 men who volunteered and were of the same age range. Both crew had been flying together for over 12 months.

Method: The 2 crews tested separately on a round the clock schedule of 4 hours duty and 2 hours rest for 15 days. Total time on duty was devoted to performance panel. Panel tests consisted of Warning lights, Auditory Vigilance, Probability Monitoring, Arithmetic Computations

and Pattern Discrimination. Psychophysiological measures included skin resistance, skin temperature, heart rate, and respiration rate. Later, 6 students were tested 4 hours a day, 5 days a week, for 6 weeks to attempt to control for monotony & repetition of tasks.

Results: Nonparametric tests were used in the analysis. The performance decrement as days passed was significant at $p<.001$ to .003 on all test measures except the following: the volunteer group decrement was not significant for either the monitoring task or the arithmetic task. Pattern Discrimination (result of learning) improved significant for the volunteer group and the combined group data. Motivation is suggested to be the reason for the group differences. Data indicates individual differences in amount and type of performance change. Dirrnal variations over the 15 day average were significant at $p<.01$, except for Probability Monitoring (% correct) and Auditory Vigilance which are significant at $p<.05$. Considering the data in 5-day blocks, only Probability Monitoring and Auditory Vigilance ($p\leq.05$), and Warning Lights (Green, $p<.01$) show sig changes only on days 6-10. Of the Psychophysiological measures, skin resistance level and fluctuation and heart rate are sig at $p<.001$, (except for heart rate$<.05$), for both groups in between-day analysis.

351. Adams, O. S., Levine, R. B., and Chiles, W. D. Research to investigate factors affecting multiple-task psychomotor performance. WADC Tech Report 59-120, Wright-Patterson AFB, Ohio, March 1959. (AD 213592)

PERFORMANCE PANEL AND PSYCHOPHYSIOLOGICAL MEASURE RELIABILITY AND TASK COMBINATION RESPONSES

Subjects: 15 volunteer college students enrolled in a training program.

Description: Subjects were tested in a 5-man flight station mock-up which included a performance panel for test presentation and subject response. Complete description, administration, and references given in the report.

Method: the study consisted of two phases, the first phase to obtain test-retest reliability figures and the second phase to test performance during different combinations of the tasks. Phase I: subjects received

II. F. Performance Panels

3 hours of practice spread over 3 days on each task. The auditory vigilance and scale position tasks and the warning lights and probability monitoring tasks were combined into one task each, resulting in 5 tasks, each task performed one hour each day. Test-retest data taken on the 4th and 5th days along with the psychophysiological measures. Phase II: Seven 2-test and three 3-test combinations were presented on the 6th and 7th days.

Results: Five of the performance test measures were significantly reliabile on the 24 hour test-retest.

Arithmetic computation (number correct)	- .787	$p<.01$
Pattern discrimination (number correct)	- .740	$p<.01$
Scale position (detection time)	- .758	$p<.01$
Warning lights (red light response time)	- .567	$p<.05$
Probability monitoring (percent correct)	- .781	$p<.01$
(detection time)	- .807	$p<.01$
(false responses)	- .926	$p<.01$

Results: Friedman's variance test for ranked data was used to determine differences in test performances on days 5, 6, and 7. Five of the test performances were significantly different under the various combinations as follows:

Arithmetic computation (number correct)	$p<.005$
Auditory vigilance (number correct/ number signals false)	$p<.10$
Scale position monitoring (detection time)	$p<.05$
(return time)	$p<.005$
Warning lights monitoring (red-light response time)	$p<.02$
(green-light response time)	$p<.001$
Probability monitoring (number correct/ number biases)	$p<.10$
(detection time)	$p<.02$
(number false responses)	$p<.05$

Bar graphs indicating the relative performance on each test, when in each of the test combinations, are given.

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352. Alluisi, E. A., Chiles, W. D., Hall, T. J., and Hawkes, G. R. Human group performance during confinement. Tech. Doc. Report No. AMRL-TDR-63-87, Project No. 1710, Task no. 171002; 6570th Aerospace Medical Research Laboratories, Wright-Patterson AFB, Ohio, November 1963. (AD 426661)

PERFORMANCE PANEL

Two work schedules are compared for 15 and 30 day confinements by means of their performance on the performance panel. Data suggests that a more demanding schedule would require more careful control of selection and motivational factors to maintain effective performance.

353. Alluisi, E. A., Hall, T. J., and Chiles, W. D. Group performance during four-hour periods of confinement. USAF: MRL TDR 62 70, June 1962.

PERFORMANCE PANEL

Test-retest reliability by Pearson product moment correlations on a battery of six performance tests: mental computation, pattern discrimination, monitoring, vigilance, and information exchange, cooperation, and coordination between members of five man crews. After a three-day training period, crews were tested four hours per day on four consecutive days with reliability estimates made between 1-2 and 3-4 days of testing.

354. Bonura, M. S., et. al. 60-Day manned test of a regenerative life support system with oxygen and water recovery. Part II: Aerospace medicine and man-machine test results. NASA CR-98500, DAC-62295, Contract NASw-1612 for Biotechnology and Human Research Div., Office of Adv. Research and Technology, NASA. McDonnell Douglas Astronautics Co., Santa Monica, California. December 1968.

PERCEPTUAL MOTOR PERFORMANCE TESTER

Summary: report covers the results of a 60-day manned test of an advanced life support system in a Space Cabin Simulator. Performance graphs are presented for the 10 tests used of the available 18 in the Perceptual Motor Performance Console.

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Subjects: four part time volunteer paid students ranging in age from 22 to 28. The subjects were screened on the basis of objective and subjective psychological evaluations, medical examinations, normality of physiology found in laboratory analysis.

Results: "All results confirmed that no subject manifested evidence of significant psychological change." (p. 18) The Performance Console tests included Arm-Hand Steadiness, Finger Dexterity, Manual Dexterity, Response Orientation, Control Precision, Multilimb Coordination, Rate Control, Perceptual Speed, Reaction Time, Mirror Tracing. The graphs indicate that performance improved, in varying amounts, for all the tests over the 60 day period. The following material is quoted from p. 51 of the report and pertains to performance on the panel: ..."In the case of the reaction time test, it is unusual to find an improvement over such an extended period. Apparently the crewmen were learning the time sequence of the stimulus presentations."...There was no deterioration in performance on the tests during the latter part of the test. Performance on the tests administered 4 days after the run was generally consistent with the levels achieved during the test. ...They indicate a lack of significant stress over the period of the test..."

"An indication was obtained early in the 60-day test that the performance tests were sensitive to changes in the condition of the crewmen...one of the crewmen developed slight cold symptoms...His performance dropped off on most of the test." Appreciable degradation occurred for the tests on Control Precision, Multilimb Coordination, Reaction Time, and Perceptual Speed.

"The fluctuation in performance between successive presentations of the tests was larger than that usually found for tests of this type. This probably reflects variations in motivation during the course of the 60-day tests. An indication of performance variability has been obtained...The standard deviation and mean score for each test are presented...

"The mean scores...are generally less than corresponding scores previously reported for the battery...Reaction time scores are exceptions... data...suggest that consideration must be given to the effects of learning in further standardization of the battery."

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355. Chambers, E. S., Johnson, L. O., Van Velzer, V. C., and White, W. J. Standard operational tasks for assessment of human performance - COMPARE design specification. Douglas Paper no. 4136, Douglas Missile & Space Systems Division, Douglas Santa Monica, California, December 1966. (AD 643 241)

Essentially the same information is also available in:
Chambers, E. S., Johnson, L. O., Van Velzer, V. C., and White, W. J. Standard operational tasks for assessment of human performance - equipment specifications for spaceborne COMPARE. Presented to 3rd Annual AIAA Meeting and Technical Demonstration, November 1967. Available as Douglas Paper No. 4249, Douglas Missile and Space Systems Division, McDonnell Douglas Corporation.

PERFORMANCE PANEL DESIGN SPECIFICATIONS

Article gives the design specifications and hardware for the research performance panel called compare which interfaces with the subject in the same manner as the one used by Chiles and Alluisi.

356. Chiles, D. W. Assessment of the performance effects of the stresses of space flight. AMRL-TR-66-192, Aerospace Medical Res. Labs., Wright-Patterson AFB, Ohio, December 1966. (AD 649 881)

PERFORMANCE PANEL

Data: performance change significant at p .01 for variation of workload by addition of other tasks to monitoring tasks (warning lights, probability, and an auditory task). Two 5-man crews and one 6-man crew studies on sleep loss & various work-rest schedules indicate the close performance relationship of the Mental Arithmetic, Code-Dock, and Target Identification tests with sleep loss, pulse rates, confinement and work schedules via graphical representation.

Description: Warning lights: 5 red and 5 green warning lights located in pairs in panel; subject depresses a switch below green light which extinguishes or a red light which illuminates. Probability monitoring: 4 moving-pointer indicators involving detection of out-of-tolerance signals combined with previously observed reading to render a decision.

Target identification: 6x6 matrix of close-butted square lights giving display appearance of bar graphs. A noise-free target was followed by two noisy targets and the subject was required to determine whether the original target was contained in noisy target A, B or both. Mental Arithmetic: three 3-digit numbers displayed, the third number being subtracted from the sum of the first two. Three problems per minute are presented; score is the total number of correct solutions. Code-lock: three differently colored indicator lights and five push buttons. A problem solving task where the subject must discover the correct order of push button depression. The only task which is not force-paced.

All of the above is incorporated into a performance panel.

Measures: monitoring of static processes (warning lights), probability monitoring: monitoring of dynamic processes and IQ, target identification: visual discrimination, short term memory and IQ, mental arithmetic: short term memory and IQ, code-lock: procedural performance, short term memory and IQ. All of the above supposed to be related to functions performed in space vehicle. Performance panel considered to be useful in studies of performance change under varying conditions.

357. French, R. S. RATER and LOGIT: A new approach to crew performance assessment. Paper presented at the I.S.A. Aerospace Instrumentation Symposium in San Diego, 14 June 1967.

RATER

Description of the Response Analysis Tester (RATER) and the Logical Inference Tester (LOGIT).

358. French, R. S. A proposal for a miniaturized Response Analysis Tester (RATER) Model 3 (Preliminary draft). Mail Zone 592-00, Convair Division of General Dynamics, San Diego, California, June 1969.

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RATER

The proposal presents a technical description of the RATER. Copies of the proposal are available from the author. To quote from the document: "...four symbols (or colors) automatically displayed in continuous, random sequence. Total presentations, total responses, correct responses, and response latency may be determined from counters or from output jacks for data processing. Modes of operation include: (1) self-pacing or auto-pacing, (2) patterned or solid color stimulus items, (3) variation in stimulus-correct response relationship and (4) immediate-versus-delayed response. Gradations of task difficult are achieved through: (1) precise, automatic control over the rate of stimulus presentation from 0.5 to 2 seconds per item for 1 to 5 minutes in the auto-paced mode and (2) the delay test mode, which requires the subject to retain the sequence memory and to respond one to four symbols behind the symbol visible at a given moment."

359. Higgins, E. A., Davis, Jr., A. W., Fiorica, V., Iampietro, P. F., Vaughan, J. A., and Funkhouser, G. E. Effects of two antihistamine-containing compounds upon performance at three altitudes. Aerospace Medicine, November 1968, 1167-1170.

HUMAN PERFORMANCE TESTER - SENSITIVITY OF PERFORMANCE

Performance on the Human Performance Tester was shown to be affected by antihistamine compounds.

360. Lincoln, R. S., and Mangelsdorf, J. E. An integrated approach to evaluating the performance capabilities and physiological state of spacecraft crews. Paper presented at Symposium on Human Physiological and Performance Determinants of Manned Space Systems Design, San Fernando Valley State College, 14 April 1965.

INTEGRATED CREW MONITORING SYSTEM

Description of the Lockheed integrated crew monitoring system including performance and physiological measures with "digital techniques for processing, displaying, and analyzing obtained data." Performance measurement

tests include: (1) a compensatory tracking task, (2) a drift monitoring task, (3) an arithmetic task, (4) a pattern comparison task, and (5) a maze task. Test-retest reliabilities range from +.30 to +.90.

361. Miller, A. K., and Lincoln, R. S. Study of human performance in a Mark IV pressure suit. Sunnyvale, California: Lockheed Missiles and Space Company Report 6-62-64-19, 15 November 1964.

INTEGRATED CREW MONITORING SYSTEM

Human performance in two subjects wearing the Mark IV pressure suit under pressurized and unpressurized conditions was studied using: (1) tracking task, (2) drift monitoring task, (3) failure correction task, (4) arithmetic task, and (5) pattern comparison task. Tracking and pushbutton operation were hindered by the space suit characteristics.

362. Miller, I., Simon, G. B., and Cohen, E. A device and tests for measuring intellectual functions during acceleration. USAF, WADD Technical Report 60-366, Wright Air Development Division, Wright-Patterson Air Force Base, Ohio, May 1960. (AD 243 635)

LIFT, LINK INTELLECTUAL FUNCTIONS TESTER (DESIGNED FOR USED WITH WADD HUMAN CENTRIFUGE)

Cost: LIFT consists of 2 units, a visual display unit which is counted in the centrifuge gondola (with a pushbutton response handgrip) and an operator control panel which permits a stationary operator to monitor and control test administration from the control room.

Data: Reliability data is based on 37 college students given all three forms of test in a paper-pencil form in a group setting. The correlations between tests 1 and 2 vary from .54 to -.10; a Fisher Z transformation yielded r = .26. An estimated reliability of .83 for a single battery resulted from the Spearman-Brown formula. The 23 tests were reorganized into 2 tests; the Pearson product-moment correlations ranged from .86 to -.01. Mean scores for 12 male link employees for 2 LIFT and 1 paper-pencil administrations are given. T-test score difference was not considered significant ($p < .05$).

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NOTE: LIFT test form only administered under 1G. So no data regarding sensitivity or reliability under G stress.

NOTE: Vision is a confounding variable.

Description: 14 one-minute tests. Test names are: Vocabulary, Same-Opposite-Different, Letters Series, Verbal Analogies, Number Series, Coding Letters, Coding Numbers, Numerical Approximations, Addition, Subtraction, Umltiplication, Division, Numerical Matching, Name Matching.

Measures: Verbal ability: first 2 tests above; Reasoning ability: next 5 tests; Mathematical ability: next 5 tests; Perceptual ability: last 2 tests.

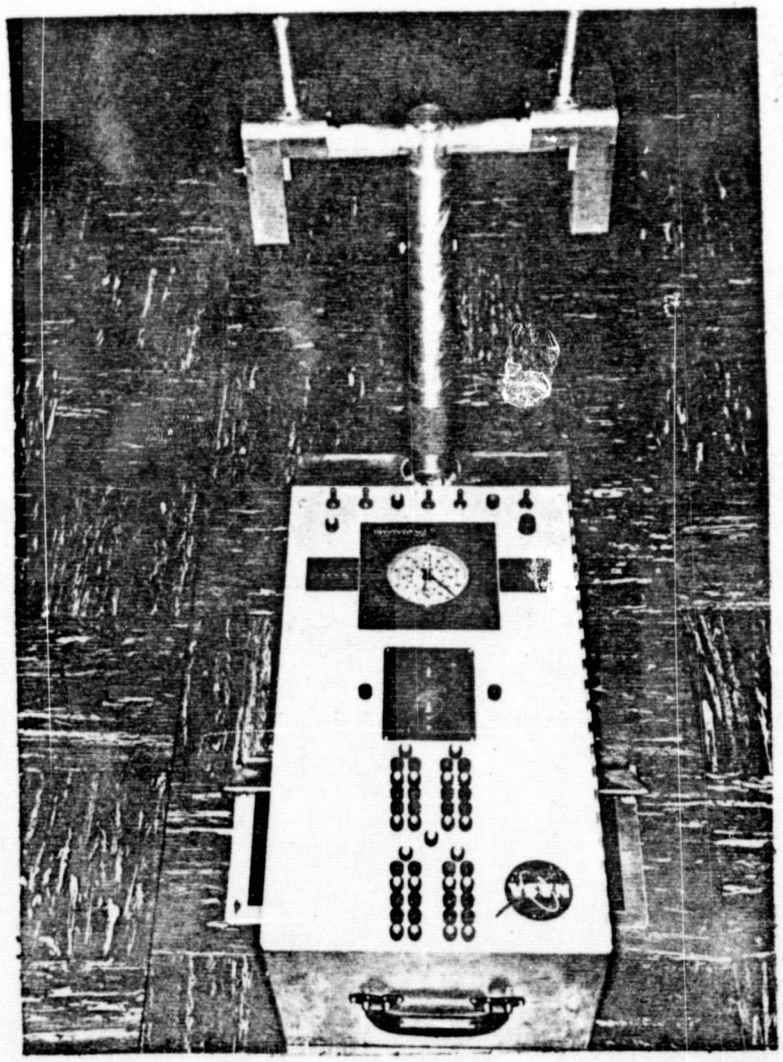
363. NASA. Proposed technical note covering the Human Performance Tester. Langley Research Station, Hampton, Virginia, May 1969.

HUMAN PERFORMANCE TESTER, OR SCOW COMPLEX COORDINATOR

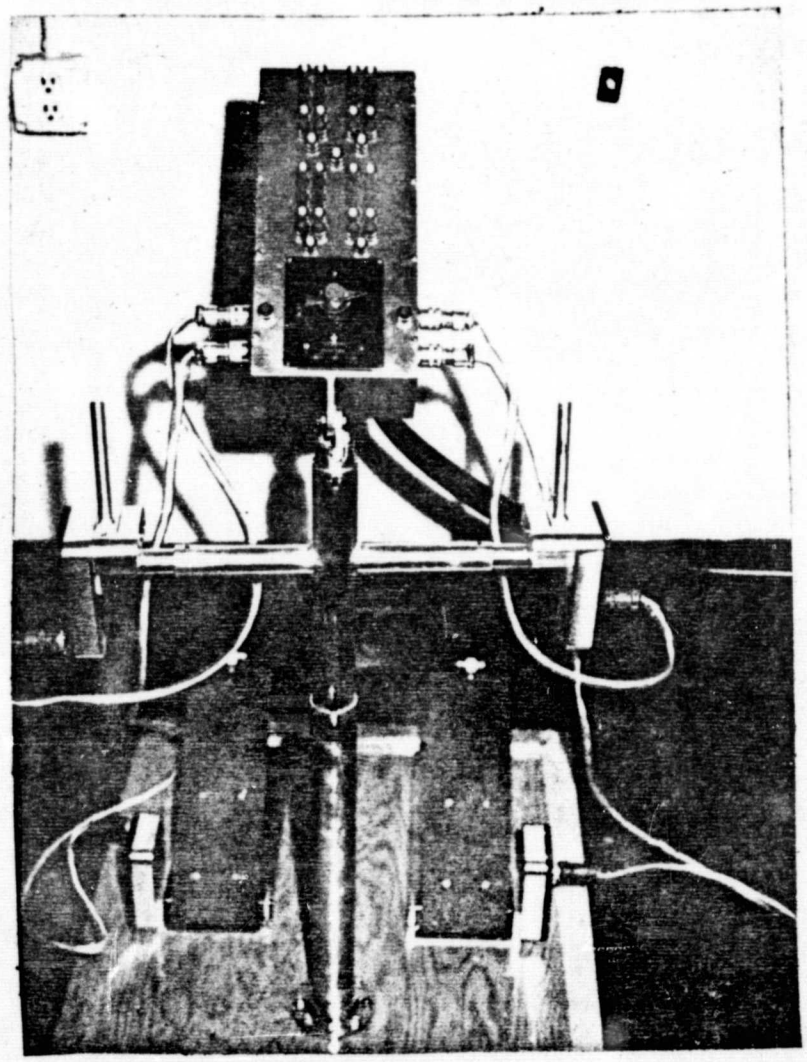
Description: an electrical device which presents to the subject a predetermined set of four stimulus lights, each located in one of four panels of lights. The subject must match these lights with four other lights, each of which is independently controlled by the movement of a particular limb. There are four limb controls for manipulating the movement of the response lights. There are presently three models in use, a portable model with snap-out drums containing 50 matching problems and two full size models with snap-out drums containing 1000 matching problems.

See following page for photographs of Portable Model and Standard Model of HUMAN PERFORMANCE TESTER.

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a. Portable Model



b. Standard Model

HUMAN PERFORMANCE TESTER

364. Newsom, B. D. Effect of instability during rotation on physiologic and perceptual-motor function. Final report of NASA contract NAS 9-6986, CR 92211. GDC-DBD67-002-12 of General Dynamics, Convair Division, June 1968. (N68-31101)

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PERCEPTUAL-MOTOR TESTER AND RATER - INSTABILITY EFFECTS ON PERFORMANCE

Reports three studies performed to evaluate the effects of an oscillating, rotating environment (using the Manned Revolving Space Station Simulator) on performance. The two studies using performance testing instruments were as follows: Task I: Baseline measurements were made on 12 subjects under static conditions using the Perceptual-Motor Tester; initial learning asymptotes were established. The tests were then repeated while the subject was exposed to (a) -3 degrees, 0.1 cps perturbation, (b) 6 RPM at a 20-foot radius, and (c) simultaneous perturbation and rotation. The mean performance scores on each of the tests under the learning sessions, each of the experimental sessions, and one post-experimental session are presented graphically. The effects on performance were differential, depending on the test and the condition. A few results are unclear due to the occurance of continued learning on the test console. Test II: After baseline measurements on 10 subjects using the Response Analysis Tester, their performance was measured after making Y-axis head turns at 0°, 45°, and 90° to the spin plane under the conditions of: (a)-3 degrees, 0.1 cps perturbation, (b) 12.4 RPM and (c) 12.4 RPM and the perturbation. The mean data is again presented graphically. The authors state "...it has been demonstrated that perturbation imposed in this experiment does not have significant effect on..." RATER performance. To quote the author's abstract: "Task III was performed to assess the perturbation effects: on the time it took for the habituation of a single perceptual element to rotation. The disorientation that results from a rapid head motion can be evaluated by the "Oculogyral Illusion" that occurs in a darkened room. An illuminated target appears to drift about and this motion is extinguished as habituation occurs...Results...indicate that,..the rate of oculogyral illusion extinction was the same, even though the extent was less, in the perturbating environment."

RESPONSE ANALYSIS TESTER (RATER)

Description: "tests correct rote responses to lights of four different colors or test symbols. The subject responds to each color by attempting to press the correct button on a console for that color light. When the correct button is pressed, the next color appears. Total responses and correct button responses are recorded automatically." (p. C-4)

Measures: report indicates the device is considered to measure orientation.

II. F. Performance Panels

365. Newsom, B. D., Brady, J. F., and O'Laughlin, T. W. Final report on a study of performance in a revolving space station simulator as a function of head rotation about Y and Z cranial axes. NASA contract NAS9-5232, General Dynamics Report No. GDC DBD 65-043012, General Dynamics, Convair Division, November 1966.

RATER

Degradation in performance on RATER as a function of Y- and Z- axis head turns at 0, 45, and 90 degree interplanar orientations in a revolving space station simulator is given for 12 male college students. The colored, no-delay, self-paced mode was used.

366. O'Connor, W. F., and Pendergrass, G. E. Task interruption and performance decrement following rapid decompression. Aerospace Medicine, June 1966, 615-617.

HUMAN PERFORMANCE TESTER - SENSITIVITY OF PERFORMANCE

Performance on the Human Performance Tester was shown to be affected by rapid decompression.

367. O'Connor, W. F., Scow, J. and Pendergrass, G. Hypoxia and performance decrement. Report No. AM 66-15, Federal Aviation Agency, Office of Aviation Medicine, Civil Aeromed. Institution, Oklahoma City, Oklahoma, May 1966.

HUMAN PERFORMANCE TESTER - SENSITIVITY OF PERFORMANCE

Performance on the Human Performance Tester was shown to be affected by hypoxia.

368. Parker, J. W. The Response Analysis Tester (RATER) and Logical Inference Tester (LOGIT): 1. Some preliminary finginds. Report 487, U.S. Navy Submarine Medical Center, Submarine Base, Groton, Conn., May 17, 1968. (AD 650 182)

RATER

74 Navy enlisted men were tested on the RATER to establish some normative data for the device. The men were tested in the colored, no delay, auto-paced (1/second) mode. They were scored on the fourth trial, the trials consisting of 5 minutes each. The score frequency distribution is presented.

369. Parker, J. W. The Response Analysis Tester (RATER) and Logical Inference Tester (LOGIT): II. Additional pilot study data. Report 525, U.S. Navy Submarine Medical Center, Submarine Base, Groton, Conn., May 17, 1968. (AD 673 996)

RATER

100 Navy enlisted men were tested on the RATER to provide further data on the device. In this instance, the symbol mode was used rather than the color mode. The score frequency distribution and an intercorrelation matrix is presented. The matrix included scores from the ARIthmetic, MECHanical, and CLERical sections of the Navy Basic Test Battery, the General Classification Test, the PIB, and grades from Submarine School. The highest correlation was .19 with CLER. The results indicate that the symbol mode may be easier than the color mode.

370. Passey, G. E., Alluisi, E. A. and Chiles, W. D. Use of the experimental method for evaluations of performance in multi-man systems. AMRL-TR-66-121, Aerospace Medical Research Laboratories, Aerospace Med. Div., AF Systems Command, Wright-Patterson AFB, Ohio, August 1966. (AD 638 183)

PERFORMANCE PANEL

Split-half reliabilities range from .451 to .969, with a median of .88

II. F. Performance Panels

371. Pearson, R. G. Alcohol-hypoxia effects upon operator tracking, monitoring and reaction time. Aerospace Medicine, March 1968, 303-307.

HUMAN PERFORMANCE TESTER - SENSITIVITY OF PERFORMANCE

Performance on the Human Performance Tester was shown to be affected by alcohol and hypoxia.

372. Reilly, R. E., and Cameron, B. J. An integrated measurement system for the study of human performance in the underwater environment. Contract No. N00014-67-C-0410, Work Unit No. NR 196-074, Office of Naval Research. BioTechnology, Inc., Falls Church, Virginia, December 1968. (AD 680 028)

SINDBAD I

"This report...describes the design and construction of a comprehensive test battery for the measurement of diver performance in wet and dry hyperbaric environments." (p. iii)

Description: designed primarily for use in the Experimental Diving Unit, the system consists of: (1) an experimenter console, (2) an electronics package containing digital and analog control circuitry, (3) a visual display system, and (4) a subject console with ancillary equipment.

Measures: tests measuring the following abilities were modified for inclusion in SINDBAD I (System for Investigation of Diver Behavior at Depth): arm-hand steadiness, associative memory, control precision, finger dexterity, flexibility of closure, flexibility of set, induction, length estimation, manual dexterity, memory span, multilimb coordination, number facility, perceptual speed, reaction time, response orientation, spatial orientation, spatial scanning, speed of arm movement, system equalization, time interval estimation, time sharing, vigilance, visualization, visual monitoring, wrist-finger speed.

373. Reilly, R. E., and Parker, J. F., Jr., Development of an improved perceptual-motor performance measurement system. NASA Contract No. NASW-1329. Biotechnology, Inc., Arlington, Virginia, August 1967.

II. F. Performance Panels

PERCEPTUAL-MOTOR PERFORMANCE TESTER

This report describes the development and fabrication of an improved version of the first performance panel. Improvements were primarily in the areas of (1) separation of the subject and the experimenter functions, thereby making the device more useful as an item of research equipment, (2) increased reliability during sustained operations, and (3) better design for maintainability.

The performance panel contains tests for each of 18 dimensions: acceleration control, arm-hand steadiness, control precision, finger dexterity, manual dexterity, mirror tracing, movement analysis, movement prediction, multilimb coordination, perceptual speed, position estimation, position reproduction, rate control, reaction time, response orientation, speed of arm movement, time sharing, and wrist-finger speed. Complete descriptions are given of each test.

374. Scow, J. A review of performance tests and suggested experiments with a new type of complex coordinator for use in aviation and the study of anoxemia. January 20, 1940. (Copies available from author at NASA-Langley Research Station, Hampton, Virginia.

HUMAN PERFORMANCE TESTER

Measures: the task is proposed to tap: psychomotor processes, monitoring and decision processes, psychophysical processes, problem solving, learning, memory, and pattern discrimination. Task performance is proposed to be indicative of flying aptitudes.

375. Smith, Seward. Development of a complex, time-shared, perceptual-motor skills task for use in studies of isolation and confinement. Research Report, MF 022.01.03-1002, Report No. 15, Naval Medical Research Institute, Bethesda, Maryland, August 1966. (AD 637 817).

COMPLEX, TIME-SHARED, PERCEPTUAL-MOTOR SKILLS TASK

Cost: a performance panel (approximately 2x1x1 feet size) including lights, switches, and earphones. It is a fully automated task including automatic print-out and magnetic tape control of the programming and data recording.

II. F. Performance Panels

Description: The task involves simultaneously, tracking, keeping a white noise turned off and turning off location coded tones. All three tasks require different controlling actions. The subject tracks the pattern traced out by one row of lights by matching this pattern with another row of lights. The noise and tones are presented to subject through a biaural headset. He pulls a lever switch to turn off the position-coded tone (which appears in either one or both of the earphones). The total program, including practice sessions, requires a half-hour. Detailed descriptions are given in the article.

Data: the mean task and error scores over four blocks of 10 trials each are given. A comparison of performance under light and dark conditions was made with no difference found. The data given indicates that learning continues over 40 trials and that the task is a difficult and confusing one.

376. Tang, P. C. and Rosenstein, R. Influence of alcohol and dramamine, alone and in combination, on psychomotor performance. Aerospace Medicine, August 1967, 818-821.

HUMAN PERFORMANCE TESTER - SENSITIVITY OF PERFORMANCE

Performance on the Human Performance Tester was shown to be affected by alcohol and/or dramamine.

II. G. Simulators

377. Belsley, S. E. Man-machine system simulation for flight vehicles. IEEE Trans. Human Factors in Electronics, 1963, HFE-4(1), 4-14.

SIMULATION CRITERIA

A critical review of criteria for man-machine system simulation with emphasis on problems of fidelity of simulation, measurement, and information objectives of simulation research.

378. Clark, D. C., and Kroll, J. General purpose airborne simulator-conceptual design report. NASA CR 544, August 1966.

AIRBORNE SIMULATOR

Describes an airborne simulator designed for research in a variety of man-machine system manual control tasks.

379. Domey, R. G., and Paterson, D. Development of a vehicle simulator for evaluating driver performance. Nat. Acad. Sci-Nat. Res. Council, Highway Research Board Bull. 330, 1962, 92-100.

VEHICLE SIMULATOR

"The most desirable approach for assessing the performance of special subgroups of the driving population is to measure behavior while operating within a controlled road-vehicle system. However, the expense, time consumption, complexity, and inherent risks involved suggest more conservative procedures before the highway system is utilized. A practical approach to the study of this problem is to obtain fundamental data in the laboratory with such instruments as universal mock-up devices or simulators. This paper is a summary description of the mechanical, electro-mechanical, tracking and data-computation features of such a simulator developed at the Harvard School of Public Health."

380. Elliott, T. K., and Folley, J. D., Jr. The maintenance task simulator-1 (MTS-1): a device for electronic maintenance research. USAF: AMRL TR 64 99, October 1964.

II. G. Simulators

An electronic simulator for the study of electronic maintenance tasks providing flexibility in the selection and complexity of simulated maintenance tasks.

381. Fletcher, J. G. Further physiologic research on human tumbling. SAM-TR-68-109, Contract AF 41(609)-2897, Systems Research Labs., Inc., San Antonio, Texas, October 1969. (AD 683 717)

ARTS

Twelve tumbling problems were investigated using the all-altitude air-bearing Research and Training Simulator (ARTS). The results indicated that among healthy persons there is a wide spectrum in tolerance to tumbling and that motion sickness and disorientation are independent factors; i.e., "...Evidence was obtained that men may be disoriented by tumbling, yet show no symptoms of motion sickness, and vice versa." (ex. abstract). Some of the subjects were able to withstand continuous tumbling for at least one hour.

382. Gillingham, K. K., Cramer, R. L., Dowd, P. J., and Collins, F. G. Design criteria for the Spatial Orientation Trainer. SAM-TR-67-90, USAF School of Aerospace Medicine, Aerospace Medical Div. (AFSC), Brooks AFB, Texas, October 1967. (AD 665 840)

SPATIAL ORIENTATION TRAINER

Article presents the design criteria and discusses the use of a Spatial Orientation Trainer which is a modified Spatial Disorientation Demonstrator. Trainer is capable of producing the Coriolis illusion, the oculogravic illusion and the graveyard spin.

383. Hardy, J. D. Acceleration. In J. D. Hardy (Ed.) Physiological problems in space exploration. Springfield, Illinois: Charles C. Thomas, 1964.

II. G. Simulators

50-FT CENTRIFUGE

Description: "A simulator which has been found valuable in the testing and training of astronauts...consists of the Johnsville centrifuge controlled by the large analog computer at the US Naval Air Development Center. In this simulator the astronaut, together with his complete spacecraft instrument and control system, is mounted in the gondola of the centrifuge and the control motions are fed directly to the analog computer. On this computer are programmed the dynamic characteristics of the aircraft or spacecraft and its control system. The computer makes an instant-by-instant calculation of the accelerations as well as the appropriate readings of the indicating instruments on the astronaut's panel. The acceleration outputs from the computer are fed into a coordinate converter so that the centrifuge controls are driven to furnish as close as approximation of the in-flight accelerations as is possible. This system permits the introduction of mechanical and electrical failures into the system and the testing of pilot reaction to such emergencies...The mean integrated error during the flight was determined..." (pp. 193-194)

Simulators of this type are used to apply desired levels of acceleration on the subject but have the disadvantage of producing disorienting rotations. The artifact of rotation is a function of the length of the centrifuge arm, therefore, a minimum length of 50 ft, is desirable to minimize the gradients of acceleration across the subject's body.

GRAY CAPSULE AND MAYO TANK

These devices are for studying effects of acceleration under partial or complete water submersion.

384. Hartman, B. O., and McKenzie, R. E. The Complex Behavior Simulator-a device for studying psychologic problems in modern weapon systems. USAF: School of Aviation Medicine Report 61 9, December 1960.

COMPLEX BEHAVIOR SIMULATOR

"A research tool for studying problems of task-induced stress in complex man-machine systems is described."

II. G. Simulators

385. Randle, R. J., and Lampkin, B. A. Sextant sighting performance in the Ames Midcourse Navigation and Guidance Simulator. In M. A. Whitcomb and Wm. Benson, (Eds.) Vision Research: Flying and Space Travel. Proceedings of Spring Meeting, 1964. Washington, D. C.: National Academy of Sciences - National Research Council, 1968. (AD 669 266)

AMES MIDCOURSE NAVIGATION AND GUIDANCE SIMULATOR

Research using this facility concerns mainly the identification and verification of performance capabilities of the human operator as an active participant in the positive fixing and guidance of the vehicle during translunar or midcourse flight.

386. Sadoff, M. and Wempe, T. E. Pilot-vehicle system simulation for low-altitude, high-speed flight. NASA TN D 2793, June 1965.

FLIGHT CONTROL REVIEW

A review of the simulation literature for low-altitude, high speed manual flight control. "Information is presented on handling qualities and stability augmentation system requirements, display and control requirements, and on the effects of cockpit acceleration environment (including an oscillatory component, assumed to approximate a predominant structural mode) on terrain-following task performance."

387. Seminara, J. L. and Gerrie, J. K. Effective mock-up utilization by the industrial design-human factors team. Human Factors, 1966, 8(4), 347-359.

MOCKUP TECHNIQUES

Discusses general techniques, and examples, by which 3-dimensional mockups can be designed, built, and used within advanced system design teams.

388. Standlee, L., and Bilinski, C. Note on simulated vs actual electronic trouble shooting performance. Perceptual and Motor Skills, 1966, 23 (2), 532.

ELECTRONICS TRAINER-TESTER

"Results of the simulated troubleshooting test indicated that the Navy's Data Systems Technicians were quite poor in troubleshooting ability. Results of the on-the-job performance evaluations, on the other hand, indicated that they were quite proficient in troubleshooting ability." The Electronics Trainer-Tester was used for simulated performance.

389. Steinemann, J. H. Comparison of performance on analogous simulated and actual troubleshooting tasks. USN Personnel Research Activity Res. Memo. SRM 67 1, July 1966.

ELECTRONICS TRAINER-TESTER

14 electronics technicians were tested in troubleshooting on a simulated task followed by the identical actual tasks. Simulated measures did not predict actual operational performance. "The evidence strongly suggests caution in assuming that a simulated performance measure, even with considerable face validity, will provide a valid estimate of actual performance on a common task."

390. Steinkamp, G. R., Hawkins, W. R., Hauty, G. T., Burwell, R. R., and Ward, J. E. Human experimentation in the space cabin simulator. Development of life support systems and results of initial seven-day flights. 59-101, Air University, School of Aviation Medicine, USAF, Brooks AFB, Texas, August 1959. (AD 226 790)

SPACE CABIN SIMULATOR

Development of the simulator and it's life support systems is discussed. The results of the initial 7-day flights are given. Marked differences were noted among the five subjects in their capability to adjust to the 4-4 work-rest cycle.

391. Vinz, F. L., Knighton, M. H., Lahser, H. F., Thomas, L. G., Howell, J. T., and Spear, J. S. Visual simulation facility for evaluation of lunar surface roving vehicles. NASA TN D-4276, February 1968.

A fixed base visual simulator is described for man-machine studies in the design of lunar surface vehicles. Visual simulation is provided by adaptation of an SMK-23 visual simulator projecting a screen view of a three-dimensional terrain model.

VOLUME III

III. MANNED SPACE VEHICLES

A. ROLES, SIMULATION, AND MEASUREMENT

B. SOURCE DOCUMENTS FOR MISSION, FUNCTION AND TASK ANALYSIS

III. A. Manned Space Vehicles, Roles, Simulation, and Measurement

392. Acken, R. A., et al. Navigator performance studies for space navigation using the NASA CV-990 research aircraft. NASA TN D-4449, 1968.

Manually operated hand-held sextants were studied at Ames Research Center to determine whether they are sufficiently accurate for midcourse haviga-tion phases of manned space flight. Studies carried out on the ground have been extended by using the NASA CV-990 aircraft. Sighting performance was evaluated by two different criteria: (1) the measurement bias error, and (2) the standard deviations of measurement error. Distinct differences between subjects were noted and attributed to the observers "personal equations." Short periods of light turbulence experienced on several flights made sighting difficult, especially with the gimballed sextant.

393. Brower, J. D. Determining flight crew capability for a manned orbital research laboratory. In P. Horowitz (Ed) Physiological and Performance determinants in manned space systems. AAS Science and Technology Series, Volume 5, 1965. Pp. 119-136.

A detailed discussion of the crew, crew duties, and work load assignments in a 6 to 9 man orbiting laboratory. The major task is performing experiments of which some 91 must be scheduled.

394. Chiles, W. D. Assessment of the performance effects of the stresses of space flight. USAF AMRL TR 66 192, December 1966.

Describes a synthetic task complex by which performance decrements as a function of the space environment may be predicted.

395. Fraser, T. M. Philosophy of simulation in a man-machine space mission system. NASA SP-102, 1966.

Overview of the literature on the use of simulation for man-machine sys-tems and particularly with respect to the space environment.

III. A. Manned Space Vehicles, Roles, Simulation, and Measurement

396. Grodsky, M. A., Moore, H. G., and Flaherty, T. M. Crew reliability during simulated space flight. J. Spacecraft & Rockets, 1966, 3 (6), 810-817.

Summarizes the results of a seven day lunar mission simulation with an attempt to identify specifically crew performance reliability for detailed task simulation.

397. Hackler, C. T., Brickel, J. R., Smith, H. E., and Cheatham, D. C. Lunar module pilot control considerations. NASA: TN D-4131, February 1968.

"The lunar module mission and the role of the pilot in spacecraft during the lunar mission are discussed...A brief description is made of the lunar module guidance and control systems, the methods of guidance in various mission phases, and the interfaces between the pilot and the guidance and control systems. The primary areas of pilot control in the various phases are examined in detail and are related to such areas as guidance monitoring, landing site inspection and change, manual updating of the guidance system, landing, and terminal rendezvous. Pilot control through the guidance system is discussed, and manual backup procedures in certain phases of the mission are examined."

398. Hagen, D. H. Crew interaction during a thirty-day simulated space flight: preliminary study. USAF: School of Aviation Medicine Report 61-66, June 1961.

"An analysis was made of crew interaction during a two-man simulated space chamber flight. By the use of the well-known Bales Interaction Process Analysis, the behavior of the two subjects was rated during 2 hours of observation each day throughout the 30-day flight. Four kinds of summary interaction profiles were compiled. The overall summary profile resembled no other in the literature."

399. Hardy, J. D. (Ed). Physiological problems in space exploration. Springfield, Ill.: Charles C. Thomas, 1964.

STRESS IN THE SPACE ENVIRONMENT

Reviews the physiological stresses and the known physiological limitations of man in space. The topics covered include temperature, energy radiations, respiration, food, weightlessness, sensation and perception, isolation and disorientation, and physiologic rhythms.

III. A. Manned Space Vehicles, Roles, Simulation, and Measurement

400. Holmes, A. E. Design, fabrication and installation of six-degree-of-freedom space maintenance simulator. USAF: AFAPL TR 64 129, April 1965.

Describes a six degree of freedom maintenance simulator supporting a single subject with back pack.

401. Jones, E. R. Some considerations regarding the definition of man's role in future space missions. In P. Horowitz (Ed.) Physiological and performance determinants in manned space systems. AAS Science and Technology Series, Volume 5, 1965. Pp. 137-148.

A discussion of the kinds of data needed about human performance in space systems and techniques for obtaining that data.

402. Johnston, D. E., and Ringland, R. F. Study, definition and analysis of pilot/system performance measurements for planetary entry experiments. NASA: CR 73171, December 1967.

"The analysis and synthesis leading to a definition of an experimental program whereby pilot performance during planetary entry can be predicted is presented. This includes an analysis of the mission to determine the piloting skills required, an examination of the literature to determine the current state of knowledge concerning skill degradation under g-forces, and the definition of an experimental program designed to provide a model predictive of human performance during planetary entry. This program relies on ground-based experimentation (human centrifuge), the results to be correlated with a limited number of in-flight entry experiments.

403. Kelley, C. R. Testing the effects of extended space missions on piloting skill. In P. Horowitz (Ed.) Physiological and performance determinants in manned space systems. AAS Science and Technology Series, Volume 5, 1965. Pp. 167-186.

III. A. Manned Space Vehicles, Roles, Simulation, and Measurement

Discussion of the use of adaptive training techniques in testing pilot skills for space missions. "A three-axis acceleration control task is suggested which adjust itself automatically until it is as difficult as the operator is able to handle. The score for such a test is in terms of how difficult a task the operator can cope with at a pre-established level of performance. The development, scoring, mechanization, and validation of such a test are discussed."

404. Kibler, A. W. The relevance of vigilance research to aerospace monitoring tasks. Human Factors, 1965, 7(2), 93-99.

The basic psychological research on vigilance is compared with monitoring tasks performed in operational systems. "It is argued that, while monitoring functions are increasing in modern technology, those particular functions on which the classical vigilance paradigm is based are declining. The difficulty of generalizing from simple laboratory vigilance tasks to the generally more complex applied monitoring functions is discussed. It is suggested that the results of classical vigilance research may not be particularly germane to contemporary monitoring problems."

405. Loats, H. L., Jr., Mattingly, G. S., and Hay, G. M. Correlation study of the simulation of Gemini extravehicular activity with flight results. NASA: CR-1146, February 1969.

Evaluation of the water immersion simulation technique for extravehicular activity. The simulation technique used a full-scale mockup of the Gemini vehicle and associated EVA equipment. "The water immersion simulation of the Gemini extravehicular activity provided a valid training time line for performance of complex extravehicular tasks and provided adequate measures of the level of work entailed."

406. Lovelace, W. R., II, Schwichtenberg, A. H., Luft, U. C., and Secrest, R. R. Selection and maintenance program for astronauts for the National Aeronautics and Space Administration. Aerospace Medicine, 1962, 33 (6), 667-684.

A four phase selection procedure covering (1) screening for obvious candidates, (2) medical and physiological testing, (3) measured tolerance to physical stress, and (4) psychiatric and psychological evaluation.

III. A. Manned Space Vehicles, Roles, Simulation, and Measurement

407. Marton, T., Helm, C. E., Green, B., and Martin, M. The assessment of human performances for the analysis of space missions. Behavioral Science, 1967, 12, 490-497.

An analysis of "...physiological and psychological variables relevant to human performance in space, the stressors that cause degradation in performance because they impair physiological and psychological functions, and the tasks that humans must perform." A quantitative task reliability estimate is derived based on the effect of each stressor on each variable.

408. Miller, G. K. Fixed-base visual-simulation study of manually controlled translation and hover maneuvers over the lunar surface. NASA TN D 3653, October 1966.

Demonstrated, in the lunar orbit and landing approach (LOLA) simulator, the ability of the pilot to assume manual control in final approach stage to lunar landing and achieve acceptable approach and hover performance.

409. Miller, G. K. A manual navigation method for evaluating transfer orbits for lunar landings. NASA TN D-4756, 1968.

"An analytical investigation has veen made of a manual navigation method which permits an astronaut in the lunar-landing modeule to evaluate his orbit as he transfers from an 80-nautical mile altitude circular orbit to a point approximately 50,000 ft. above the lunar surface. When the local horizontal is known, the method requires only the astronaut's use of a sextant to measure the elevation angle to the command module and the depression angle to the lunar horizon relative to the local horizontal at a single specified measurement point and four simple guidance charts."

410. Prodan, J. Two man space station simulator. In P. Horowitz (Ed.) Physiological and performance determinants in manned space systems. AAS Science and Technology Series, Volume 5, 1965. Pp. 101-117.

III. A. Manned Space Vehicles, Roles, Simulation, and Measurement

A fifteen-day, two pilot, simulated earth orbit mission with a wide spectrum of performance requirements including sample mission tasks, and human performance tasks. Three performance tests (number retention, bi-manual matching, and reaction time) showed high performance levels throughout the simulated mission without decrement while imbedded in other tasks. Stresses the point that skilled test pilots can be expected to perform "...well in excess of that which is normally expected."

411. Reid, R., and Saucer, R. T. Examination of onboard training for extended space flights. NASA: TN D 2162, November 1964.

Using a three-axis moving base simulator relatively simple vehicle control tasks were evaluated as possible imbedded training tasks for extended space missions where performance levels must be maintained over long periods of time.

412. Roth, E. M. (Ed.) Compendium of human responses to the aerospace environment. NASA Contractor Report 1205. Lovelace Foundation for Medical Education and Research, Alburquereque, New Mexico, November 1968, 4 volumes.

HUMAN RESPONSE TO THE AEROSPACE ENVIRONMENT

The compendium covers the available knowledge on the environmental-physiological interface under normal and abnormal conditions. A valuable source of reference materials, it is, as the authors note, "...a compromise between the specific needs of the engineering community and those of consultants in the life sciences." (p. v)

413. Secord, T. C., and Bonura, M. S. Life support systems data from sixty-two days of testing in a manned space laboratory simulator. J. Spacecraft and Rockets, 1966, 3(10), 1527-1533.

Describes testing and use of integrated life support and environmental control systems in a space cabin simulator. Data provided on crew (4-man) troubleshooting and repair.

III. A. Manned Space Vehicles, Roles, Simulation, and Measurement

414. Sells, S. B. A model for the social system for the multiman extended duration space ship. Aerospace Medicine, 1966, 37(11), 1130-1135.

Based on past literature and experience with small task groups performing under adverse, sustained conditions, suggests a model for group optimization in the extended duration space mission.

415. Silva, R. M., et al. Initial results of the Air Force space navigation experiment on Gemini. USAF, AFAL-TR-66-183, 1966.

"The purpose of this experiment is to examine techniques and equipment for performing the manned vehicle space navigation task without resorting to automatic or powered equipment. The data obtained was mostly qualitative and established design criteria for the second flight on Gemini 7. The existence of a 5577-angstrom green line on the visible horizon was firmly established, and the inability to use a window for celestial observations on the daylight side of the earth, was discovered during the GT-4 flight."

416. Streimer, I., and Wendrow, B. The implications of space crew physical fitness maintenance to system design. J. Astronautical Sciences, 1965, 12(1), 27-29.

"The necessity for space crew exercise has been previously discussed in the literature and the institution of mandatory exercise programs specifically designed to minimize the anticipated deleterious effects advocated. If for discussions sake we assume that exercise will maintain space crews in desired physical condition, 2 considerations arise which can drastically alter current concepts of system sizing and design. The first consideration stems from the question of how much exercise will be required per man day and the second from the question of whether exercise requirements increase with increasing mission duration."

417. Vinograd, S. P. Medical aspects of an orbiting research laboratory. NASA SP-86, 1966.

Report of the Space Medicine Advisory Group Study on an orbiting research laboratory covering: (1) life support recommendations, (2) inflight medical experiments, and (3) design and operational recommendations.

III. A. Manned Space Vehicles, Roles, Simulation, and Measurement

418. Young, H. A catalog of simulators for training space flight personnel. New York University: Contract Nobsr 89288, May 1965, (AD 624227).

A listing of simulation devices available for space flight training within NASA, AF, Navy and Army facilities.

III. B. Source Documents For Mission, Function and Task Analysis

419. Acken, R. A., et al. Navigator Performance Studies for Space Navigation Using the NASA CV-990 Research Aircraft. NASA: NASA-TN-D-4449, April 1968. (N68-21123)

Describes the experiments being conducted with hand held sextants for space navigation purposes.

420. Akulinichev, I. T. Evaluating the state and activity of crew members under conditions of prolonged space flight. "Navka", Moscow, 1967.

Describes a writing test to determine the astronaut's condition while in orbit.

421. Alelyunas, P. Checkout: Man's Changing Role. Space/Aeronautics, 1965, 46(12), 66-73.

A discussion of man's capabilities in spacecraft repair with block diagrams of in-flight checkout procedures.

422. Bauerschmidt, D. K., and Besco, R. O. Human Engineering criteria for Manned Space Flight: Minimum Manual Systems. USAF: AMRL-TDR 62-87, 1962.

Analytical and experimental investigation of simple or minimum guidance and control systems were conducted.

423. Beaudry, W. A., et al. Crew Motion and the Dynamic Environment of Spaceborn Experiments. NASA: NASA-CR-61566, January 1968. (N68-20358)

An analytic study of the effects of crew motion on the dynamic environment of orbiting laboratories.

III. B. Source Documents for Mission, Function and Task Analysis

424. Bedwell, T. C., Jr., et al. Bioastronautics and the exploration of Space. Aerospace Medical Division, Brooks AFB, Texas, December 1965. (AD 627-686)

A symposium which covered the whole range of bioastronautics including the MOL.

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