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AIR FORCE HUMAN RESOURCES LABORATORY QUARTERLY RESEARCH
AND DEVELOPMENT SUMMARY FOR JANUARY - MARCH 1985(U) AIR
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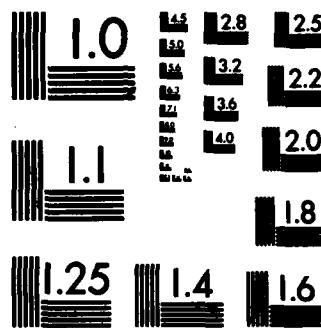
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AIR FORCE



QUARTERLY R&D SUMMARY
JANUARY - MARCH 1985

Edited by

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PREFACE

This document contains a summary of each Air Force Human Resources Laboratory Technical Report and Technical Paper that the Aerospace Medical Division Public Affairs Office has approved for public release during the past 3 months. It does not include summaries of Special Reports, nor Technical Reports and Technical Papers not cleared for public distribution.

In addition, the unlimited distribution technical documents published during this quarter are listed. All are available from the Defense Technical Information Center, Cameron Station, Alexandria, Virginia 22314, to qualified requesters and from the National Technical Information Service, Springfield, Virginia 22151. The AD number should be included on requests for documents.

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This report provides abstracts of research on:

SUMMARIES

Collins, D.L. Psychological issues relevant to astronaut selection for long-duration space flight: A review of the literature, AFHRL-TP-84-41. Manpower and Personnel Division.

This technical paper reviews the current literature on psychological issues relevant to astronaut selection for long-duration space flights. Interpersonal problems have been and remain a recurring problem for both short- and long-duration space flights. Even after completion of the space mission, intense psychological after-effects are reported. The specific behavioral problems experienced during both United States and Soviet Union space flights are reviewed, specifically addressing contentious episodes and impaired judgements that occurred during the Mercury, Apollo, and Skylab missions.

Psychological tests used in the selection process for the space program have focussed primarily on the detection of gross psychopathologies in potential candidates. Although these psychological instruments excluded some people from becoming astronauts, the battery of tests failed to predict which individuals would manifest behavioral aberrations in judgement, cooperative functioning, overt irritability, or destructive interpersonal actions.

As mission length, crew size, and diversity increase, behavioral problems can be expected to persist. Therefore, it is recommended that research and development (R&D) be planned to improve the selection of space crews. Such R&D should include the following topical areas: evaluation of the utility of the Personal Attributes Questionnaire (PAQ) masculinity/femininity scale to select androgynous individuals for long-duration space flights; personality and leadership factors important in crew composition, with specific attention to crew compatibility; types of leadership style best suited for short- or long-duration space flights; the determination of that critical point in time during a space flight where the situational factors (such as boredom, crew friction, apathy) become an obstacle to effective leadership; identification of psychological supports or props that can be used to help individuals preserve or restore their emotional stability under conditions of isolation and confinement. Such a comprehensive R&D program is suggested as a possible joint effort between National the Aeronautics and Space Administration and the Air Force Human Resources Laboratory.

Ward, J.H., Jr., Treat, B.R., & Albert, W.G. General applications of hierarchical grouping using the HIER-GRP computer program, AFHRL-TP-84-42. Brooks AFB, TX: Manpower and Personnel Division.

A common problem in personnel research applications is to take a collection of k objects (tasks, ratings, regression equations, etc.) and to combine them into meaningful groups based on some measure of similarity. A hierarchical grouping procedure starts by grouping two elements together which are "least different" and, at later stages, combining two groups together which are least different. The process is such that one less group remains after each grouping, and it continues until the original collection is reduced to one group. One way to measure the difference between two groups is to calculate the increase in some overall measure of the error made by treating all the elements of each group the same. When the objects involved are regression equations, and a prediction system consists of one regression equation for each group (with data pooled within groups), an increase in the error measure corresponds to a decrease (or loss) in predictive efficiency. HIER-GRP is a computer program which has been used extensively to perform this kind of hierarchical grouping on regression equations which satisfy a proportionality condition. This paper describes a method for using HIER-GRP, without modification, to perform grouping in more general situations. A simple method is shown for changing many more general problems into proportional regression clustering problems. Applications include: (1) grouping prediction systems which are not proportional, (2) grouping raters on similarity of response profiles, (3) grouping jobs (or technical schools) to minimize loss of differential classification effectiveness, and (4) grouping columns or rows of a standard transportation problem to simplify the calculations.

Wainer, H., & Thissen, D. Estimating ability with the wrong model, AFHRL-TR-84-45. Brooks AFB, TX: Manpower and Personnel Division.

No model is ever a perfect reflection of the data it is built to summarize. There are always errors of fit. This is as true with modern item response theory (IRT) as with all other models. It is important to know to what extent the accuracy of measurement made with these models is perturbed by misfit and what can be done to minimize the inaccuracy. First, a detailed general model was fit to ASVAB (Armed Services Vocational Aptitude Battery) data to provide the framework for a realistic simulation structure. Then three of the most commonly used IRT models were fit in this simulation. A variety of robust estimators of ability were used and the accuracy and efficiency of each estimator was determined. With short tests, a simple model coupled with a robust estimator seemed to be the methodology of choice for describing the data. As test length increased, so too did the benefits of utilizing a more complex parameterization. An unexpected finding was that coupling robust estimators with a Bayesian prior yielded substantial shrinkage. Future work on ability estimation, especially for practical applications of adaptive testing, is required to "unshrink" ability estimates.

Kemmer-Richardson, S., Lamos, J.P., & West, A.S. Computer-assisted instruction: Decision Handbook, AFHRL-TR-84-46. Lowry AFB, CO: Training Systems Division.

The Computer-Assisted Instruction: Decision Handbook has been written for use as a resource and reference guide for Air Force instructional managers who are considering the adoption or expansion of computer-assisted instruction (CAI) at some future time and also as a decision aid for an instructional manager currently involved in the CAI decision process. The use of the handbook is appropriate for considering the implementation of CAI in a new course or in an existing course. Its contents are designed to be helpful where CAI systems are already available to the trainers, as well as in those cases in which the adoption of CAI requires new system acquisition. Field tests of the handbook were conducted at Sheppard and Keesler Air Force Bases late in 1983. The tests included a formative evaluation to improve the format and presentation of the handbook and an implementation analysis in order to estimate the resources required for appropriate application of the manual as a decision tool. The workbook portion of the handbook presents specific tools, in the form of worksheets, for evaluating the need for CAI, for identifying configurations most closely matched to instructional needs and practices, and for estimating the feasibility of initiating CAI implementation.

Ree, M.J., Valentine, L.D., Jr., & Earles, J.A. The 1980 youth population: A verification report, AFHRL-TP-84-47. Brooks AFB, TX: Manpower and Personnel Division.

An investigation was conducted to verify the results of a report written by the Center for Naval Analyses (CNA) on the proposed adoption of the 1980 Youth Population as a new norming reference for scores for the Armed Services Vocational Aptitude Battery (ASVAB). This verification was conducted primarily to provide Air Force personnel and manpower planners with information on the general implications of switching to a new normative score scale. The approach used was to replicate the CNA analyses to confirm results relevant to the Air Force and to provide a comparison of the 1980 score scale generated under operational procedures with the 1944 score scale. The data base for the analyses was test scores for 9,173 males and females contained in the 1980 youth sample who were administered Form 8a of the ASVAB. Comparisons were made between the 1980 and 1944 (operational) score scales for all subjects, for males only, and for females only. Comparisons were made for the Armed Forces Qualification Test (AFQT) and the four Air Force selection and classification composite scores. Results indicated that there were numerous implications pertaining to the AFQT. Using the 1980 reference population for establishing AFQT mental category boundaries will have substantial impact on the number of applicants classified as Category I or II and may require changes to operational procedures in the Air Force. Although the use of the 1980 reference population and adjusting cut-off scores will have a negligible effect on three of the four composites, it will have a substantial impact on the Mechanical aptitude composite. Recomputation of the CNA analyses indicated that frequency distributions and percentages were essentially correct although the CNA computations were not based on operational procedures. Other issues addressed in the technical, operational, and organizational realms resulted in a recommendation that other organizations affected by this decision (e.g., Air Training Command, Air Force Manpower and Personnel Center) should be given the opportunity to review and evaluate the impact resulting from the selection of a new reference population.

Goldstein, I.L., Gagne, R.M., Glaser, R., Royer, J.M., Shuell, T.J., & Payne, D.L. Air Force Learning Research Laboratory: Proposed research issues, AFHRL-TP-84-48. Brooks AFB, TX: Manpower and Personnel Division.

This paper documents the proceedings of a workshop which was convened to formulate the technical program for the establishment of a learning research facility at the Air Force Human Resources Laboratory. Attendees at the workshop included nationally recognized experts in instructional psychology from academia and the other service laboratories. These participants were asked to review the needs of the Air Force, compare those needs with relevant technology, and propose approaches for a productive research program. Each expert presented his view of contemporary research and theory in instructional psychology and identified a set of research issues believed to be critical for the refinement of training procedures in the Air Force. The research issues identified provide an excellent foundation for the development of new research initiatives in the learning and training areas.

Carroll, R.J., Goodman, D.L., Hritz, R.J., Chiplock, L.W., & Trump, T.R. Maintenance training simulators: Logistical support cost considerations in design and acquisition, AFHRL-TP-84-49. Lowry AFB, CO: Training Systems Division.

Although maintenance trainer simulators have become widely accepted and used in many different types of training environments, very little information is available or known about the logistical support cost of various types of maintenance simulators. The primary objective of this effort was to provide a systematic approach whereby the logistical support cost factors of maintenance simulators could be easily identified by the military. Relevant literature was reviewed, and a sample of different maintenance simulator personnel (i.e., instructors, course managers, operators, maintainers, and other subject-matter experts) were interviewed to determine those factors which influence the logistical support costs associated with maintenance simulators. A handbook was developed to enable the user to easily identify support cost factors associated with the design, acquisition, and utilization of maintenance simulators. Some examples of maintenance simulator logistical cost information and a suggested detailed cost collection format for the acquisition of future maintenance simulators were also provided.

Gordon, S.E. Manual and computer-aided sequential diagnostic inference, AFHRL-TP-84-51. Wright-Patterson AFB, OH: Logistics and Human Factors Division.

It is becoming increasingly obvious that computerized automation can be a useful aid for a wide variety of positions in the command and control network where many of the tasks involve situational assessment or "diagnostic inference." To optimally combine human talent and computer-aiding systems, one must know how the human operator performs the task unaided (and under what circumstances), what subtasks can be allocated to the machine, and what variables affect operator acceptance of the aiding system. This paper presents a theoretical model of the human performance of a diagnostic inference task when unaided by machine, including the variables affecting those inference processes; and a preliminary model of how a computer-aiding system might be expected to fit into the diagnostic system.

Hughes, R.G., & Brown, L. Trends shaping advanced aircrew training capabilities through the 1990s, AFHRL-TP-84-52. Williams AFB, AZ: Operations Training Division.

Simulation has the potential for becoming a major force multiplier influencing aircrew readiness in the 1990s, but not if given a continuation of the narrow focus characterizing the field today. Major underlying reasons are perceived to be more closely related to the lack of sound training "system" design, than to engineering or technology issues per se. Computer image generation and newer "hybrid" systems will prove capable of satisfying current and projected scene content requirements. Head- and eye-coupled display systems will both reduce overall visual system costs as well as provide high-brightness displays with resolution able to support even the most visually demanding tasks. Hardware costs will moderate but software costs will continue to increase, especially as increased capability leads to the requirement for the simulation of greater mission complexity. Together, these factors will work against the need to field this new technology at levels (e.g., wing and squadron) where frequent aircrew practice of critical skills can be assured. Instead, costs will continue to drive the user to centralized facilities for both advanced range and simulator systems alike. Access to training at this level will continue to be infrequent, on the order of every 12-18 months. Because of these trends, potential advantages are possible through a functional (and in some cases geographical) integration of major aircrew training resources, advanced simulators, and instrumented ranges. A substantially improved continuation training capability at the unit level will require improved concepts of onboard simulation and embedded training. These concepts, to the extent that they would make maximum use of the operational equipment itself, must be consistent with the need for training system capabilities adequate to support Air Force 2000 needs to field and sustain a highly mobile and dispersed force.

Kyllonen, P. Learning abilities measurement program: Dimensions of information processing speed, AFHRL-TP-84-56. Brooks AFB, TX: Manpower and Personnel Division. p. 6

Computerized assessment provides to yield scores that indicate how quickly individuals think, solve problems, make decisions, or more generally, process information. There is a question, however, of how many processing speed scores are necessary to adequately characterize an individual's capabilities. One possibility is that some people think faster than others on all kinds of tasks. An alternative is that some are faster than others on certain tasks but slower on different tasks. The purpose of this effort was to review three studies conducted as part of the Learning Abilities Measurement Program (Project LAMP) that collected data pertaining to this general issue of the dimensionality of processing speed. In three separate studies, large groups of Air Force basic trainees (N=508, 178, 710, respectively) were administered a wide variety of computerized tasks designed to tap verbal, quantitative, reasoning, decision, classification and choice skills. Various multivariate analysis techniques were applied to the response time data from these tasks in order to determine whether a single speed factor could account for subject-to-subject variability or whether multiple speed factors were required. In the first study, the data could roughly be accounted for by a general speed factor, but a much better account could be made if separate reasoning speed, verbal speed, and quantitative speed factors were posited.

Similarly, in the second and third studies, a general speed factor was found, but the data could be more easily accommodated by positing additional factors, such as perceptual processing speed and memory search speed. These studies represent an important first step in determining the number and nature of information processing speed factors. Further basic research is necessary to develop a theory-based taxonomy of information processing speed variables before assessment applications can be pursued systematically. Nevertheless, exploratory application efforts might benefit from a consideration of the kinds of processing speed dimensions discussed in this paper.

Brooks, R.B. Radar warning receiver special function trainer: Preliminary evaluation, *and* AFHRL-TP-84-59. Williams AFB, AZ: Operations Training Division.

Current Radar Warning Receiver (RWR) skills can mean the difference between life and death for fighter pilots. These skills are so important that the pilot should not have to think, but should respond almost automatically. The pilot must understand the operation of the indicator control panel and the azimuth indicator, as well as have a current knowledge of threat capabilities, in order to utilize the RWR device. RWR skills are difficult to acquire and maintain. Pilots do not have free time to study and review the written procedures as frequently as necessary to stay current in RWR skills. In order to practice RWR skills in the aircraft, aircrews must fly over instrumented ranges. There are very few such ranges, and only limited range time is available to individual aircrew members for training. Aircrews currently have little opportunity to use their Electronic Combat (EC) systems, and they need alternative means of becoming proficient in order to maximize their chances of survival in a hostile environment.

The RWR skills are difficult for aircrews to acquire and maintain. A possible solution to this RWR training problem is the application of microcomputer technology to develop Special Function Trainers (SFTs). SFTs are microcomputer-based training aids designed to help the aircrew member acquire new skills or to refresh existing ones. The objective of this effort was to determine Tactical Air Command (TAC) pilots' perceptions of the usefulness of the trainer as a training aid. Questionnaires were administered both to instructor pilots and to student pilots. Both groups found the trainer to be "useful" to "very useful" as a training aid and stated that it would be more useful to students than to operational pilots. All evaluators stated that the audio feature contributed little to the usefulness of the trainer and, in addition, stated that several features could be made easier to use through modification. The RWR SFT offers flexible, relatively inexpensive training that the TAC pilots believe will be useful.

Fairbank, B.A., Jr. Equipercntile test equating: The effects of presmoothing and postsmoothing on the magnitude of sample-dependent errors. AFHRL-TR-84-64.
Brooks AFB, TX: Manpower and Personnel Division.

The Air Force requires effective methods for test equating. Among the tests which must be equated are the various forms of the Armed Services Vocational Aptitude Battery (ASVAB). Equipercntile test equating is typically used to equate the different forms of the ASVAB to earlier forms and to each other. Increases in the accuracy of equipercntile test equating may be achieved by increasing the size of the samples of examinees. The purpose of the present effort was to determine whether statistical smoothing could also increase the accuracy of equating. Two classes of simple smoothing methods are of interest - presmoothing of the score distributions and postsmoothing of the equipercntile points. A third class of smoothing methods, called combined smoothers, involved both presmoothing and postsmoothing. The research used three methods to investigate fourteen simple smoothers and five combined smoothers. The first method used simulations based on a theory of ability testing. Simulated tests were developed to mimic statistical aspects of ASVAB subtests. Those tests were equated with and without smoothing and the results were evaluated. The second and third methods used existing operationally obtained data. In the second method, very large samples of examinees were used to establish highly accurate equatings, then smaller samples were drawn and equated with and without smoothing. The third method of investigation used the statistical jack-knife, a general purpose statistical tool, to estimate standard errors. Negative hypergeometric presmoothing was clearly more effective than the other presmoother. Two of the postsmoothers were somewhat more effective than the other postsmoothers. The negative hypergeometric presmoother resulted in a reduction of approximately ten percent in one measure of equating error; its use would correspond in effectiveness to an increase of approximately twenty percent in the size of the samples used for equating. The effective postsmoothers were (1) orthogonal regression, which was more effective than ordinary least squares linear regression, and (2) the use of cubic smoothing splines, which was the most effective of the postsmoothers. No postsmoother was as effective as presmoothing with the negative hypergeometric. Combining presmoother and postsmoothers did not result in an improvement beyond that obtained with the more effective of the combined pair used alone. Modest but significant gains in the accuracy of equipercntile test equating may be achieved through the use of negative hypergeometric presmoothing.

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