BOOK REVIEWS

VERNON, PHILIP. *The Structure of Human Abilities.* Methuen's Manuals of Modern Psychology. London: Methuen & Co. Ltd.; New York: John Wiley & Sons, Inc., pp. 160.

Regardless of your factor-analytic faith, regardless of your disposition to worship *g*, tolerate it, ignore it, or deny it, you will be pleased with this clear, non-technical exposition of factor analysis. Professor Vernon writes, "I assume only that the reader has had an elementary course in psychology and knows what an intelligence test and a correlation coefficient are." He succeeds in holding to this assumption and yet is able to cover with admirable lucidity the fundamental concepts of factor analysis, the problems and limitations that it is currently facing, and the several conflicting theories.

This is a fine general description. Someone who has been working with factor analysis a long time will find the book goes over much familiar ground. In spite of this, such a person will find it very worth while, especially in demonstrating how the familiar concepts may be verbalized. The book is very appropriate for students as an introduction to the subject of factor analysis and for workers in other areas of testing and of psychology who want to know more about all the argument.

The dedication reads, "*to* C. Burt and G. H. Thomson (with whom I almost always agree) *and to* L. L. Thurstone and the late C. E. Spearman (with whom I usually disagree)." Vernon indicates at all points his preference for the extraction of *g* and a few major group factors. Nevertheless his discussion of the general concepts of factor analysis is entirely suitable for devotees of all methods, and his comparison of the diverse methods, although definitely one-sided, is by far the clearest brief explanation of the situation that is available.

The first three chapters explain the general theory of factor analysis and its limitations, its historical development, the differences among the several methods, and the author's preferred group-factor method and its special implications. Considerable attention is paid to the hierarchical group-factor theory of the structure of abilities. The position is taken that *g* heads the hierarchy, that the major group factors verbal:educational (*v:ed*) and spatial:mechanical (*k:m*) are on a second level, that the minor group factors are at a third level, and that specific factors branch down from there. Vernon admits that the hierarchy is not perfect; for example, scientific ability cuts across the two major group factors. He points out that factors at any level can be obtained by means of an appropriate selection of tests. The reviewer feels that to emphasize this hierarchy as a way of visualizing the structure of abilities will prove to be misleading, since any test can be placed at any level in the hierarchy simply by properly selecting the other tests in the battery. The usefulness of factor analysis rests, to a large extent, on the existence of natural clusters of correlated tests reflecting certain unities of function. The most parsimonious hypothesis regarding the structuring of these clusters or factors is that they be regarded as variously extended and sized and variously overlapping behavior syndromes with perhaps a tendency for the cognitive kind to overlap a common area—*g*.

The first three chapters beautifully set forth the reasons for using the factor-analytic method, its uses, and its limitations. These are described from the viewpoint of the up-to-date worker in the field and cover all the important considerations that should be borne in mind while using the method. Most of these are considerations that would be equally well agreed to by users of all factor-analytic methods. Here, for example, are discussions of faculties vs. factors, factor analysis as an empirical approach to human abilities, identification of factors, limitations of factor analysis, broad and narrow group factors, effects of range on factor patterns, the effect of age on factor patterns, and many other problems.

Some two-thirds of the book is devoted to chapters discussing the factorial findings in the various areas of testing. These chapters present the results of both British and American studies in a discursive rather than tabular manner. On the whole they give a very fair picture of the findings, including a very fair picture of the confusions. The more technically oriented reader may have occasion to find some fault with these chapters for several reasons: (1) the results of the various factorial studies are discussed without indication as to method of analysis, (2) the results are discussed by reference to test names with no further indication as to what the tests are like, and (3) coverage of studies is only moderate, some areas such as personality being ignored completely.

A 7-page appendix compares the general-plus-group-factor theories with the multiple-factor theories. Although devotees of Thurstone's method will not agree with the import of that appendix, they will find it a remarkably precise statement of the theoretical differences. Most of the appendix is devoted to seven reasons for the superiority of general-plus-group-factors. These are given below, each condensed into one sentence. (1) In all but highly selected populations g is too big to belittle. (Vernon indicates, however, that sometimes we are interested in selecting populations and that multiple-factor analysis can reveal group factors in such situations that the general-plus-group-factor method might obscure.) (2) g and the major group factors are more nearly invariant than are multiple factors with changing populations and changing tests. (3) Group factoring is quicker than multiple factoring. (4) The "primary" factors are so divisible that it is difficult to see where factorization is to stop, except by stopping with the smallest factors that are useful, presumably either practically or conceptually. (5) Since no test measures a single factor and the g or other content must be removed by a suppressor test, why not admit that all tests involve g, instead of artificially removing it by means of rotation? (6) Hierarchy is not merely a statistical artifact; it is best understood in terms of general-plus-group-factor theory. (7) The multiple-factor theories encourage factor naming and the false belief that tests will predict success on jobs having activities apparently similar to those involved in the factor, while a short battery of the major group factors, *v:ed* and *k:m*, will serve almost all predictive purposes.

It is not within the scope of this review to present the opposing view on each of these points. Perhaps the opposition would have most to say on the subject of invariance. They would maintain that the particular g extracted from a given battery depends upon the particular tests included, and that the group factors are also dependant on the particular tests included until rotation finds the natural clusters in several areas where some consistency in the reactions of the subjects results in concomitant variation of test scores.

In conclusion it should be emphasized that the value of a book does not depend on the extent to which the reader agrees with its contents. Although the reviewer prefers a school of thought widely different from that of the author, the book, particularly Chapters 1-3 and the appendix, was found by him to be remarkably stimulating and a great clarifier of a muddled situation.

Educational Testing Service *John W. French*

ADKINS, DOROTHY C., AND LYERLY, SAMUEL B. *Factor Analysis of Reasoning Tests.* Chapel Hill: Univ. North Carolina Press, 1952, pp. iv + 122. $2.00.

Until very recently, the realm of reasoning abilities was probably the least adequately explored of the recognized cognitive functions. Neither in the definitive studies of Thurstone nor in the comprehensive factorial investigations of the Army Air Forces Psychology Program (Guilford and associates) appear consistent or satisfactory determinations of reasoning factors. The authors of this book, recognizing the need for intensive investigation of the

reasoning domain, report a project designed "to clarify the underlying nature of the abilities affecting performance in types of tests that have been identified previously or suggested as measures of reasoning" (p. 4).

The report is presented in two sections. In Part I is described a factor analysis of 38 tests, selected on the basis of their factorial content, from the battery included in the Army Air Forces Psychology Program, Report No. 5, *Printed Classification Tests.* The correlations analyzed were those reported in the Air Force study. On the basis of the analysis, 18 tests were chosen for inclusion in the 66-variable study reported in Part II. The other tests administered for this second, major analysis were chosen from a variety of sources, and some were developed specifically for this study. In addition to the 65 tests finally selected, the number of years of formal schooling was included as a variable. Subjects were 200 enlisted men, selected by performance on an Army classification aptitude battery to be representative of the population of enlisted men in the Army. Following the normalization of all variables, product-moment correlation coefficients were computed (IBM equipment was used) and a centroid factor analysis was performed.

Where the aim of a factor analysis project is to discover consistent, meaningful constellations of ability from the interrelations among a group of variables, the editorial selection of variables is obviously of crucial importance. It is noteworthy that the authors agreed "to devote a sizeable portion of the available resources to deciding upon, selecting or constructing, and editing the tests to be used" (p. 4). The literature was systematically reviewed for test ideas. Individual psychologists and philosophers were invited to submit test ideas and hypotheses as to the nature of reasoning. There is presented evidence of careful selection of tests which cover a wide range of reasoning tasks. In addition, tests measuring non-reasoning abilities were included—at least two such tests for each of nine previously identified factors, e.g., Verbal Relations, Number, Space factors, Closure factors, etc.

To prevent the ambiguity of interpretation which arises when a factor is defined by tests alike in type of mental operation but also alike in medium of presentation, tests considered to be of similar function were chosen from differing media of presentation. One of a number of examples of the perspicacity of this approach appears in the interpretation of one of the reasoning factors, named "Perception of Abstract Similarities." The factor is defined by two verbal classification tests, two figures classification tests, both verbal and figure analogies tests, and a test of analogies of meaningful pictures. It is apparent that the process underlying successful performance on the tests transcends the medium in which they are presented, at least within the limitations of a group-administered paper and pencil test battery.

Sixteen centroid factors were extracted and rotated into oblique simple structure. For thirteen of these, interpretations are offered. Four reasoning factors are presented. In addition to the factor "Perception of Abstract Similarities," reasoning factors have been named "Hypothesis Verification" (best defined by the series of Raven's Progressive Matrices tests), "Deduction," the ability to draw correct inferences (best defined by False Premises and Identical Forms tests), and "Concept Formation" (best defined by tests demanding that the subject assign to a group of objects pictured or named the name of the narrowest category which subsumes all objects). Also suggested to be allied to reasoning is "Flexibility of Perceptual Closure," Thurstone's second closure factor, one of the nine reference factors in the analysis.

The interpretations which appear in the book, in general, are convincing. They depend not only upon the characteristics of tests exhibiting high factor loadings, but also upon the nature of tests not exhibiting high factor loadings—it is often of critical importance to discover "Why not?" There is apparently a tacit recognition of the provisional character necessarily imposed, by inherent limitations of factor analysis, upon interpretations of rotated factors. The frequent references to earlier studies are of considerable aid to the reader

in establishing similarities between factors here reported and those identified in previous investigations of mental abilities. Differences, too, are reported, particularly with respect to the Air Force studies. There is discovered no correspondence between the characteristics of the several reasoning factors discussed in the Air Force Report No. 5 and those of the reasoning factors isolated here. To the reviewer the interpretations of the present study seem to provide a more satisfactory picture of reasoning abilities and the interpretations make good sense, psychologically. However, further investigation of the discrepancies certainly is warranted.

In most respects, this book is extremely comprehensive. Each test is described succinctly in terms of content, time limits, scoring formula, etc., and both raw score and normalized score frequency distributions are exhibited. Complete tables of test intercorrelations and of 16th-factor residuals are presented, in addition to tables of centroid and oblique factor loadings, the transformation matrix, and the matrix of cosines of reference vectors. Useful information which might have been presented, but is not, includes the distribution of number of items completed on each test (from which it would be possible to obtain an estimate of the level of chance performance) and graphical representation of pairs of reasoning factors (to supply pictorial guidance for the assessment of interrelations among these factors).

This work provides considerable advance toward the goal of organizing our knowledge of reasoning abilities. The study supplies a framework of hypotheses, the confirmation or revision of which might be expected to lead directly to stable primary abilities of reasoning. In addition to serving as a guide valuable to both theoreticians and practitioners interested in the measurement of intellective functions, the study serves as an example of one of the most fruitful applications of factor analysis methods.

University of Chicago *Lyle V. Jones*

LLOYD A. JEFFRESS (Ed.), *Cerebral Mechanisms in Behavior, The Hixon Symposium.* New York: John Wiley, 1951, pp. xiv + 311, $6.50.

This book contains the papers given during the Hixon Symposium at the California Institute of Technology in September, 1948. Following each paper is an edited transcript of the discussion.

The first paper, by John von Neumann, is "The General and Logical Theory of Automata." Dr. von Neumann runs through the similarities and some of the critical differences between artificial and natural automata, between computing machines and the central nervous system. He concludes that the inferiority of our materials and the absence of any adequate theory prevents us from attaining the high degree of complication and the small dimensions of natural automata. The McCulloch-Pitts theory, built on the present system of formal logic, is inadequate. A new logic is needed whose procedures allow a low but non-zero probability of errors. Turing's results are extended to a theory for self-reproducing automata. The paper was received by the other participants with skeptical remarks like the following:

McCulloch, "I envy Dr. von Neumann the fact that the machines with which he has to cope are those for which he has, from the beginning, a blueprint of what the machine is supposed to do and how it is supposed to do it."

Gerard, "I have had the privilege of hearing Dr. von Neumann speak on various occasions, and I always find myself in the delightful but difficult role of hanging on to the tail of a kite."

Weiss, "I question whether a mechanism in which all these innumerable contingencies have been foreseen, and the corresponding corrective measures built in, is actually conceivable."

Lashley, "It seems to me the question of precision of the organic machine has been somewhat exaggerated."

Halstead, "I suspect that von Neumann biases his automata towards rationality by careful regulation of the energies of the substrate."

Lorente de Nó, "Possibly the automaton can be made to maintain memory, but the automaton that does would not have the properties of our nervous system."

Warren S. McCulloch presented the second paper, "Why the Mind is in the Head." He asserts that the nervous system is par excellence a logical machine. It is a highly redundant machine because information handling capacity is sacrificed for dependability. The notion of negative feedback is considered to be neurophysiologically important. Finally, McCulloch reviews in some detail the neural circuits he has proposed for form perception. This paper evoked such remarks as:

Lorente de Nó, "Dr. McCulloch has brought what we know of both the anatomy and the physiology of the brain closer to an integrated whole than it has ever been before."

von Neumann, "I see the plausibility of what you say, but I still have a residue of uncertainty left."

Gerard, "If these networks of neurons are organized so beautifully in the striate, then how do you account for some of Dr. Lashley's critical experiments on destruction of different parts of the brain?"

Köhler, "I admire the courage with which Dr. McCulloch tries to relate his neurophysiology to facts in psychology. But I sometimes feel like criticizing the results."

Lashley, "I am very much in sympathy with the type of development represented in the last two papers. At the present time, however, such a formulation involves a great oversimplification of the problems."

The third paper, by Lorente de Nó, had to be omitted. The fourth, "The Problem of Serial Order in Behavior," was given by K. S. Lashley. Lashley argues that the temporal organization of behavior has never been properly considered. The notion of chains of associated reflexes is not adequate. A variety of examples, most of them linguistic, lead Lashley to consider a "priming" mechanism that gets responses ready before they occur. Temporal order is probably closely related to spatial order. The other participants commented:

Klüver, "In my opinion, this is the first time since 1914 that a neurological thinker has presented such a trenchant analysis of the role of the time factor in behavior."

Halstead, "I have been greatly impressed with the case that Dr. Lashley has made for nonspecific, non-mosaic representation."

Gerard, "I find it impossible to think through or even towards the complexities of behavior if restricted to atomic units travelling along atomic fibers."

Lorente de Nó, "While I was listening there was going through my head a mental picture of a number of experiments that I intend to perform—suggested to me by Dr. Lashley's speech."

Weiss, "The great value of Dr. Lashley's presentation lies in the fact that it places rigorous limitations upon the free flight of our fancy in designing models of the nervous system."

The fifth paper, by Heinrich Klüver, was "Functional Differences between the Occipital and Temporal Lobes." Klüver reviews his work on the occipital and temporal lobes. Removing the occipital lobe causes a monkey to behave as though his eye were a simple photocell which records only changes in light flux. Removing the temporal lobes does not produce much sensory effect but causes remarkable change in behavior. Klüver then calls attention to extracerebral mechanisms that exert obscure influences on the brain and illustrates them by his own work on the role of porphyrins in the central nervous system. Sample comments were:

McCulloch, "Each time we get one of these problems in which we are concerned on the one side with chemistry, and on the other side with the structure of the nervous system, we get into difficulties which take us years and years to solve."

Gerard, "I am particularly grateful to Dr. Klüver for, in a sense, putting the brain back in the body."

Köhler, "I have perhaps missed the connection between the two parts of Dr. Klüver's paper."

Wolfgang Köhler read the sixth paper, "Relational Determination in Perception." He begins with a review of his experiments on figural after-effects and argues that they should be interpreted in terms of direct currents flowing through the brain tissue. This argument led to experiments searching for such direct currents. Some reactions to this paper were:

Lashley, "I am at a loss to see where further development of the theory will lead."

Lorente de Nó, "From looking at your records I don't see any reason why they are not perfectly legitimate records and why we are not now in the presence of a new phenomenon in physiology."

Gerard, "It is somewhat to the shame of physiologists that the spontaneous rhythm of the human brain was discovered by a psychiatrist—the Berger rhythm. Now, again, it is not a physiologist, but a psychologist who has had the courage to try a reasonable gamble and look for his still slower changes directly in the human brain. I am much inclined to think that he has found them."

Liddell, "How do you propose to follow this clue of the slowly fluctuating cortical potentials when you change over to the kinesthetic and tactile fields?"

The seventh paper, "Brain and Intelligence," was given by Ward C. Halstead. His paper follows along many of the ideas of his book *Brain and Intelligence* and treats the effects of lesions on intelligence, the factors in biological intelligence, the role of the frontal lobes, etc. His paper evoked such comments as:

Lashley, "I think this is the most promising method of approach to the whole problem of cerebral localization that has been made."

Nielsen, "Dr. Halstead is the only psychologist that I have ever heard of who can tell by his psychological tests that the frontal lobes have been taken off."

Klüver, "Dr. Halstead's intensive analysis has thrown new light on the functional significance of the frontal lobes."

Lindsley, 'I am sure that the stimulation of Dr. Halstead's work will direct a number of psychologists into this kind of application."

The volume closes with a review of the symposium from the viewpoint of a clinician,

Henry W. Brosin. He says the great strength of the group is their willingness to tolerate partial answers, proposes that color responses on the Rorschach test should be of especial interest to neurophysiologists, and wonders if psychology will not find its "great man" in the person who can combine the concepts of Freud with the ideals of Wundt. These remarks by Dr. Brosin were extemporaneous.

If this review gives a somewhat confused picture of the book, then it correctly summarizes the reviewer's impression. The papers are uniformly good and will be useful to give graduate students an introduction to the thinking of these famous scientists. The discussion is heterogeneous, sometimes inaccurate, seldom documented, and usually disorganized. The possibility of a general theory of behavior based on cerebral mechanisms looks faintly hopeful at first, but deteriorates as the symposium progresses. At least one reader closed the book with the impression that the study of behavior has much more to contribute to our knowledge of cerebral mechanisms than vice versa.

Massachusetts Institute of Technology *G. A. Miller*

NORMAN FREDERIKSEN AND W. B. SCHRADER, *Adjustment to College*. Princeton: Educational Testing Service, 1951, pp. XVII + 504.

Soon after the veterans began to pour into our colleges and universities at the end of World War II, educators started to deliver opinions and research workers analyses of data about veterans' adjustment to college. The large number and complexity of the factors involved cast doubts on both the opinions and the analyses of data. Opinions were too vulnerable to the effects of sentimental and financial considerations. Virtually all of the reported studies failed to control one or more of such relevant factors as year in class, predicted academic performance (e.g., high-school rank and college aptitude score), division of the college in which the student was enrolled, and the specifics associated with one institution as compared to others.

It is fortunate, then, that this study of a well-planned sample of sixteen colleges and universities was made possible through the financial assistance of the Carnegie Corporation and the consultative resources of the Educational Testing Service, of which the authors are staff members. Here we have a definitive answer based upon a sophisticated analysis of the question.

Not only was academic achievement, through the medium of grades, investigated but a questionnaire was administered dealing with facts of personal history and status, attitudes toward college and college grades, worries and anxieties, use of time, and factors bearing on the importance of the "GI Bill" in determining college attendance. The questionnaire was administered in the fall of 1946 and a sample of approximately 11,000 distributed through the sixteen institutions was drawn.

Through an application of covariance analysis which permitted the use of an index representing the variance in grades unaccounted for by measures of high-school success and aptitude and achievement, ability was ruled out as a factor in the comparisons of veterans and non-veterans. These two groups were compared within institution, further subdivided by sex, class, and division. They find that the hypothesis that veterans excel non-veterans of equal ability is supported. For freshmen, however, this tendency is small. Even in the most extreme instances (groups), the advantage of the veterans would on the average amount to no more than the difference between C and C+.

There is a wealth of information in the analyses of the questionnaire responses, but for the most part no spectacular differences between veterans and non-veterans in motivational adjustment are revealed. Veterans' worries, if anything, are fewer than the non-

veterans', though somewhat differently distributed. The veterans were more concerned about financial problems and concentration, while non-veterans were more concerned about feelings of inferiority and social adjustment. Of special interest from the point of view of national educational policy are findings related to non-aptitude determiners of going to college. The veterans were drawn from families of less educational background and lower income than their non-veteran counterparts. At the same time students who are older and from lower socio-economic groups tend to be overachievers. Specificity and certainty of vocational choice were other outstanding factors in overachievement.

The meticulous interpretation of data is marred by one instance. The lack of correlation between date of testing and test scores and grade achievement is taken as evidence that "the time of taking the test has little effect on the predictive value of the test" (p. 59). This lack of correlation with date of testing does not preclude the possibility that the correlation of *test scores* taken a year earlier with grades will be lower than the correlation of *test scores* taken at the start of the current year. However, this fault is a minor one in an otherwise-well planned, thoroughly analyzed study.

University of Michigan *Edward S. Bordin*

BOOKS RECEIVED

ASHBY, W. ROSS. *Design for a Brain.* New York: John Wiley and Sons, Inc., 1952, pp ix + 260.

BARLOW, FRED. *Mental Prodigies.* New York: Philosophical Library, 1952, pp. 256.

BERRIEN, F. K. *Practical Psychology* (Revised Edition). New York: The MacMillan Co., 1952, pp. xv + 640.

Bureau of Psychology, U.P., Allahabad. *An Educational Guidance Project.* Allahabad: Bureau of Psychology, Uttar Pradesh, 1952, ii + 82.

CHESSER, EUSTACE. *Cruelty to Children.* New York: Philosophical Library, 1952, pp. 159.

COCHRAN, WILLIAM G. *Sampling Techniques.* New York: John Wiley and Sons, Inc., 1953, xiv + 330.

COOMBS, CLYDE H. *A Theory of Psychological Scaling.* Engineering Research Bulletin No. 34. Ann Arbor: Univ. Michigan Press, 1952, pp. vi + 94.

DEMING, W. E. *Some Theory of Sampling.* New York: John Wiley and Sons, Inc., 1950, pp. xvii + 602.

EDUCATIONAL TESTING SERVICE. *A Summary of Statistics on the Selective Service College Qualification Test.* Princeton: Educational Testing Service, 1952, pp. 71.

GOULDEN, CYRIL H. *Methods of Statistical Analysis.* New York: John Wiley and Sons, Inc., 1952, pp. vi + 440.

HYNDMAN, OLAN R., M.D. *The Origin of Life and the Evolution of Living Things.* New York: Philosophical Library, 1952, pp. xxi + 648.

KARPF, FAY B. *The Psychology and Psychotherapy of Otto Rank.* New York: Philosophical Library, 1953, ix + 129.

LANDIS, PAUL H., AND STONE, CAROLL. *The Relationship of Parental Authority Patterns to Teenage Adjustments.* Bulletin No. 538. Washington Agricultural Experiment Stations. Pullman, Wash.: State College of Washington, 1952, pp. 31.

MAIER, NORMAN R. F. *Principles of Human Relations: Applications to Management.* New York: John Wiley and Sons, Inc., 1952, pp. ix + 474.

PALMER, HAROLD, M.D. *The Philosophy of Psychiatry.* New York: Philosophical Library, 1952, pp. ix + 70.

PODOLSKY, EDWARD (Editor). *Encyclopedia of Aberrations.* New York: Philosophical Library, 1953, viii + 550.