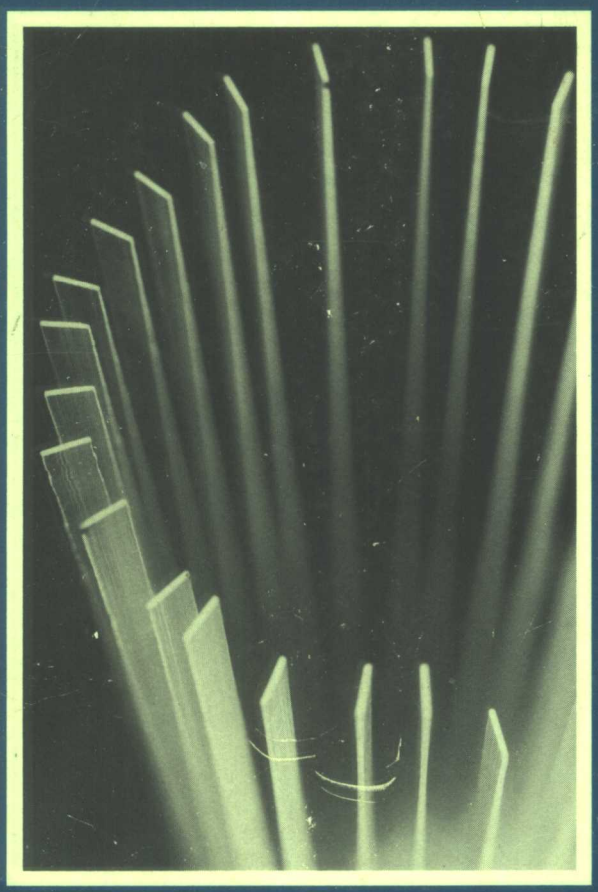


Readings in Industrial and Organizational Psychology

Frank J. Landy

Readings in Industrial and Organizational Psychology

Edited by
Frank J. Landy

The Dorsey Press
Chicago, Illinois 60604

CONTENTS

INTRODUCTION

In the past 20 years, industrial and organizational psychology has become very complex. This increased complexity is due, in part, to the rapidly expanding technology of business and government. The introduction of computers and robots to the workplace, the laws that govern fair employment practices, and expansion of service jobs represent challenges to industrial and organizational psychology that did not exist 20 years ago. The expansion of the field is also due to the fact that theories have been developed where, before, there were none. In the late 1940s, applied psychology was characterized as "dust-bowl empiricism." This was meant to imply that there was little concern for *why* relationships between variables were observed. The concern seemed to be for predictability rather than understanding. That narrow concern for predictability has also changed. Theories of information processing, work motivation, leadership, and performance evaluation have appeared to fill the conspicuous substantive gaps that existed 20 years ago.

The most obvious symbol of this expansion in industrial and organizational psychology is the breadth and depth of research literature. The size of the body of knowledge supporting the field has grown geometrically. There are seven or eight major journals that serve the industrial-organizational student and researcher. Collectively, these journals represent about 5,000 *new* pages of reading material each year. In addition to these major journals, there are dozens of supporting journals that include articles of direct interest to the industrial and organizational psychologist. Add to the journal pages the information contributed by new *books* in the field and you begin to appreciate the meaning of the term *information explosion*.

This information explosion represents something of a dilemma. On one hand, there is simply too much for any one person to read. On the other hand, the *science* of industrial and organizational psychology demands an awareness of recent developments in theory and research findings. For the student, the dilemma is often addressed by finding a comprehensive textbook that covers most of the important material in the field. Necessarily, the student is reading predigested theory and research that has been already "processed" by the author of the textbook. This leaves something to be desired. As any author will tell you, there is no good substitute for reading original sources, i.e. the actual articles themselves rather than results or theory abstracted and modified to suit the purposes of the textbook author.

It is this dual concern for the integrity of original sources and the need to be selective in reading that provides the logical foundation for readings books. These books attempt to present to the reader a balanced selection of articles that are well written and comprehensive. If the readings are up to date and the selection representative of the field, the readings book can make an enormous contribution to the student's understanding of the field. This is what I hope to accomplish with this current book of readings. I have included articles in all of the major areas of industrial and organizational psychology—most of them published within the last five years. Others, though published earlier, remain central to an understanding of the nature of work behavior and thus deserve exposure.

In selecting the readings, several forces have influenced me. I mentioned two of those forces above—currency and comprehensiveness. In most sections, I have included a review piece that serves two purposes. First, it pulls together the major points of interest in a particular area for the student to consider simultaneously. Second, it presents the student with

a comprehensive list of articles covering research and theory in that area. For the student who would like to pursue additional reading or research in that area, the most difficult part of the literature review is already completed.

Another influence in the selection of readings for each chapter has been application. In most sections, one or more real world problems is represented by a reading. This provides a link between the principles of behavior as manifest in industrial settings and the application of those principles. An additional influence was the desire to expose the student to the scientific method as it is practiced by industrial and organizational psychologists. As a result, each section has one or more research studies included to show how important questions are posed using the powerful language and analytic strategies that represent the scientific method. Finally, in each section, I have included nonempirical readings that are intended to stimulate original thinking and give the reader a break from the demanding characteristics of scientific reading. Most often, these nonempirical readings are in the form of an essay. They are intended to balance the comprehensiveness of the reviews and the technical detail of the empirical research with a broader and more thoughtful consideration of topics within an area. In other words, each section is heterogeneous in composition, with each reading directed toward a somewhat different end.

Although there are 14 major sections in the book, these sections can be reduced to four overarching categories: (*a*) personnel psychology, (*b*) industrial-social psychology, (*c*) human factors psychology, and (*d*) the field of industrial and organizational psychology in perspective. The first two areas receive a great deal more attention than the last two. Each section will be introduced by a brief description of what is to be covered in that section as well as a statement indicating how and why that section is important to the student of work behavior. In addition, each reading within the sections will be introduced by a paragraph explaining its unique contribution and thrust.

Approximately 25 percent of the readings have been condensed. More often than not this was accomplished by eliminating some of the statistical and technical detail. Occasionally, particularly in the case of review articles, summaries were substituted for detailed descriptions of reviewed literature. These reductions were necessary in order to maintain a book of reasonable length that was, nevertheless, comprehensive. Two other modifications were made to conserve space. All of the references from a reading appear in the general reference section at the end of the book. Article abstracts, reference notes, and some nonessential footnotes have also been eliminated from the readings. By making these minor concessions, I have been able to include additional pages of text material to better serve the student.

This readings book has been designed in a way that makes it compatible with any general text in industrial and organizational psychology. The sections and topics covered by the readings are representative of topics covered by most of the general texts in the industrial and organizational area. There is no doubt that I have included articles that other authors might not have included. Similarly, others might have included articles that I have ignored. Nevertheless, in my opinion, the readings that comprise this book represent an excellent cross section of theory, research, application, and speculation in the field of industrial and organizational psychology as it currently exists. I hope that those who use the book will agree.

In putting this book together, I had the assistance of a trio of reviewers who gave willingly of their time and expertise to guide me in the selection and editing of the readings. Jeff Burroughs, Kevin Murphy, and Bob Vance read all of my initial selections carefully and helped me decide what readings to keep, and they also helped identify others that I had not originally planned on including. Wendy Becker was also helpful in identifying articles for possible inclusion. I am grateful to them and, in some measure, any success that this book enjoys will be due to them.

SECTION ONE

Job Analysis and Job Evaluation

Personnel psychology is based on the proposition that a work task, a collection of tasks, or a job can be completely and accurately described in behavioral terms. Typically, this description is a list of duties and responsibilities—often called a job description. The process used to produce this description is called job analysis and this analysis can be carried out in several ways. One method of job analysis involves watching the worker perform the tasks under examination and making notes about those tasks. A second method is for the job analyst to actually perform the tasks or the job to get an appreciation for the duties and responsibilities. A third, and increasingly common, method of completing a job analysis is to ask people who hold the job to complete a questionnaire that tells the analyst about the relative importance of individual tasks and the frequency with which those tasks are performed.

Once the tasks are clearly and completely described, it is possible to identify the knowledges, skills, abilities, and other personal characteristics that an individual should possess in order to successfully complete those tasks. This second stage is often called an abilities analysis, and it accompanies and supports the job analysis. Once you know what knowledge, skills, and abilities the job requires, you can choose or develop the measures of those knowledges, skills, and abilities—the actual predictors of performance.

After the job and abilities analyses are completed, there are many possible applications of the resulting information. For example, it is then possible to develop tests to identify potentially successful employees and develop training programs for preparing individuals to meet the demands of a particular job. In addition, it is possible to use duties and requisite abilities to determine how much money to pay people who hold the job title under consideration. This last process is called job evaluation.

In this section, readings will be presented that address these three issues: job analysis, abilities analysis, and job evaluation.

The leading figure in abilities analysis in applied settings is Ed Fleishman. Over 30 years ago, he began to develop methods for identifying the unique abilities that workers use to carry out various tasks. He has conducted both field and laboratory research involving both military and civilian occupations. As a result of this research, he has developed a taxonomy or list of abilities that could be used to accomplish any task. In this reading, Fleishman describes the value of this taxonomy in applied psychology, some of the history of its development, and the relationship between abilities analysis and task analysis.

■ READING 1 ■

Toward a Taxonomy of Human Performance

Edwin A. Fleishman
University of California, Irvine

Much research in the behavioral sciences is concerned with the study of factors affecting human task performance. Thus, we may study the effects on task performance of different training methods, different environments and conditions of work, attitudinal and group factors, and individual differences in abilities. It is surprising, therefore, that more attempts have not been made to conceptualize a set of variables common to these areas, namely those associated with the kinds of *tasks* that people perform.

For some years, a number of us have been concerned with the need to develop a set of concepts that might help us make more dependable generalizations of research results to new tasks. The essential problem is the need to generalize the effect of some training, environmental, or procedural condition, from knowledge of its effect on one task, to its probable effect on some other task. What has been lacking is a system for classifying such tasks that would lead to improved generalizations and predictions about how such factors affect human performance (cf. Fleishman, 1967b; Gagné, 1964). In particular, what is needed is a learning and performance theory that ascribes a central role to task dimensions.

Not too long ago a favorite distinction in psychology textbooks was between "mental" and "motor" tasks or between "cognitive" and "non-cognitive" tasks. Such broad distinctions are clearly too all-inclusive for generalizing results obtained on the effect of some learning or other condition to some new task. Job analysts, on the other hand, have developed highly detailed task analysis systems, but these are often too specific to particular jobs to help us arrive at general task dimensions applicable across many different tasks and jobs. Other psychologists (such as Alluisi, 1967; Gagné, 1964; Miller, 1966) have proposed categories of tasks in terms of broad human functions required to perform them. For example, such categories as *identification, discrimination, sequence learning, motor skill, scanning*, and *problem solving* are terms that have been used in the literature. However, everything we know from actual correlations among human performances indicates a considerable diversity of functions

Source: *American Psychologist*, December 1975, pp. 1127–1133; 1140–1142.

within each of these broad areas. The recent work by McCormick and his associates (e.g., McCormick, Jeanneret, & Mecham, 1972) explicitly recognizes this.

The need for a better conceptualization of task dimensions relates to some other pressing problems of our field. The recent challenges to our selection methodology intensify the need to search for better methods of job analysis conceptually linked to more analytical criterion measures of job performance. A taxonomic system of task dimensions should assist in this.

It has been my feeling over the years that some kind of taxonomy of human performance is required which provides an integrative framework and common language applicable to a variety of basic and applied areas. Such a taxonomy should have certain characteristics. It should identify important correlates of learning, criterion performance levels, and individual differences *and* should be applicable to laboratory tasks and to tasks encountered in on-the-job situations.

Although the need has been recognized (e.g., Fitts, 1962; Melton & Briggs, 1960; Miller, 1962), it is only recently that concerted attempts have been made to explore more intensively some of the issues and alternatives in taxonomic development in psychology and to proceed on an *empirical* basis in the evaluation of these alternatives. I would like to review a program of research that has made at least some beginnings in this area.

Specifically, this article discusses briefly some general problems in the development of taxonomic systems applicable to descriptions of human performance and tasks. Some alternative approaches and provisional classification schemes developed are described. Then, some attempts to *evaluate* the utility and validity of these systems are reviewed.

SOME TAXONOMIC ISSUES[1]

Early in our research program we reviewed the literature bearing on taxonomic approaches and concepts in the behavioral sciences as well as related developments in other sciences (Chambers, 1973; Farina, 1973; Theologus, 1973; Wheaton, 1973). We cannot provide the details of this review here, but we can indicate some issues that stood out.

Purpose of Classification

We need to be clear on why we are interested in task classification. The question is important because individuals who attempt such classification usually do not view the development of such a system as an end, in and of itself. Rather, they view the system of classification as a tool to increase their ability to interpret or predict some facet of human performance (Cotterman, Note 1). This goal is to be achieved by seeking relationships between that which is classified (e.g., tasks, processes mediating performance) and selected variables of interest to a particular investigator (e.g., distribution of practice, training regimens, environmental stressors).

We can elect to develop a system of classification having utility for a limited area (e.g., the classification of tasks with respect to which certain training methods are found most effective in promoting high levels of task performance), or we may look for a system from which a *variety* of applications may stem. For example, we might first classify tasks and *only then* relate stressors, learning principles, training regimens, etc., to each class of tasks in this system. In this case, classification is designed from inception to be general and to serve a variety of users by aiding in the interpretation, prediction, or control of a broad range of human performance phenomena.

With respect to systems having rather specific applied objectives, classifications dealing with training are most numerous. A number of investigators (Annett & Duncan, 1967; Gagné, 1962; Miller, 1966; Cotterman, Note 1; Eckstrand, Note 2; Folley, Note 3; Stolurow, Note 4) have called for systems intended to permit the classification of tasks into sets of categories that are relatively homogeneous with respect to principles of learning, training

[1]The author is indebted to George W. Wheaton for his contributions to the conceptual phase of this research.

techniques, etc. Bloom (1956) has attempted to develop a similar taxonomic system for the educational community. However, few empirical evaluations of such systems have been attempted.

Where broad task classification systems are developed as autonomous structures, which are only some time later to be applied to other variables, the classification exercise is an integral step in the development of theory. The resultant system provides a consistent conceptual framework, the elements of which eventually are to be used in the interpretation or prediction of human performance. One is not precluded from seeking specific applications for such classifications. The point is that a specific application does not dictate the composition and structure of the system.

Learning theorists have engaged in these pursuits (see Melton, 1964), but as yet there is no comprehensive system that effectively compares, contrasts, and interrelates the various human learning "categories."[2] Consequently, we have been unable to formulate a general theory of learning which allows dependable generalizations of learning principles to particular classes of tasks. Gagné (1964) has been the most systematic in the specification of general "learning categories" and their potential implications for ordering principles of learning.

The ability theorists also have attempted to isolate basic dimensions of behavior on which a general theory of human performance might be based. Guilford (1967) and I (Fleishman, 1964) have been perhaps the most explicit in attempting to integrate the ability dimensions identified within the general framework of experimental psychology. Thus, my associates and I have conducted research relating ability dimensions identified in research on individual differences to stages of learning (Fleishman & Hempel, 1954, 1955), stimulus-response relations (Fleishman, 1957), skill retention (Fleishman & Parker, 1962), part-whole task relations (Fleishman, 1965), effects of drugs (Elkin, Freedle, Van Cott, & Fleishman, Note 5), etc. This variety of studies was possible because we first attempted to develop a standard and consistent classificatory structure of human abilities and then attempted to test the feasibility of this framework across different areas of human performance. This approach is examined later in this article.

Conceptual Bases of Classification

After the consideration of the purposes of task classification, one needs to examine the descriptive bases of taxonomy. A concern here is with the definition and meaning of the concept *task*.

Definition of the Task. Task definitions vary greatly with respect to their breadth of coverage. At one end of this dimension are definitions that view the task as the totality of the situation imposed on the subject. For example, this definition would consider ambient stimuli an integral part of the task. The other end of this dimension is represented by definitions that treat a task as a specific *performance.* In this case, for example, one task could be to "depress the button whenever the light comes on." Suffice it to say that very different concepts may underlie definitions falling at either end of this dimension.

This diversity of opinion is also reflected in the extent to which tasks are defined as being external to or an intrinsic part of the subject. Some definitions take into account the propensity of subjects to redefine an imposed task in terms of their own needs, values, experiences, etc. In the grossest sense, these definitions treat a task as whatever it is the subject *perceives* the task to be. Other investigators (e.g., Hackman, 1970) define the task in terms of stimulus materials and instruction to the subject. The instructions indicate the activities to be performed with respect to the stimuli and the goals to be achieved. Merely giving a person a broken radio would not be assigning him a task.

Most investigators treat tasks as consisting of interrelated processes and activities. For example, Miller (1966) stated that "A task is any

[2]For a recent attempt in the area of instrumental conditioning, see Wood (1974).

set of activities, occurring at about the same time, sharing some common purpose that is recognized by the task performer" (p. 11).

Our conclusion was that we should not debate about *the* definition of a "task" as if only one were possible. Rather, we must adopt or develop a definition that will permit the derivation of terms that reliably describe tasks and distinguish among them. These derived terms can provide the conceptual basis for classification, as we shall see later.

There appear to be four major conceptual bases underlying current task description and classification.

Behavior Description Approach. In this conceptual approach to task classification, categories of tasks are formulated based on observations and descriptions of what operators actually do while performing a task. Most often, overt behaviors such as dial setting, meter reading, and soldering are employed. In spite of the large number of terms available for this approach to task description, relatively few descriptive systems have been developed that are based exclusively on operator behaviors or activities. McCormick (Note 6) has employed this descriptive approach in his studies of worker-oriented job variables (e.g., handling objects, personal contact with customers), and Fine (Note 7) has used this approach as a basis for describing worker functions in terms of handling (things), analyzing (data), and negotiating (with people).

Behavior Requirements Approach. A second approach to "task" description emphasizes the cataloging of behaviors that are assumed to be *required* in order to achieve criterion levels of performance. The human operator is assumed to possess a large repertoire of processes that will serve to *intervene* between stimulus events and responses. There has been a great deal of interest in codifying the required intervening processes (functions, behaviors, etc.), cataloging tasks in terms of the types of processes required for successful performance, and then relating to particular training methodologies the types of tasks that emerge (see Annett & Duncan, 1967; Gagné & Bolles, 1963; Miller, 1966; and Eckstrand, Note 2). Typical of the functions used to differentiate among tasks are scanning function, short-term memory, long-term memory, decision making, and problem solving.

Ability Requirements Approach. The third conceptual basis for the description and classification of tasks, which we call the ability requirements approach (e.g., see Fleishman, 1972), is in many respects similar to the behavioral requirements concept. Tasks are to be described, contrasted, and compared in terms of the abilities that a given task requires of the operator. These abilities are relatively enduring attributes of the individual performing the task. The assumption is made that specific tasks will require certain abilities if performance is to be maximized. Tasks requiring similar abilities would be placed within the same category or would be said to be similar.

The abilities approach differs from the behavior requirements approach primarily in terms of concept derivation and level of description. The ability concepts are empirically derived through factor-analytic studies and are treated as more basic units than the behavior functions.

Task Characteristics Approach. A fourth approach differs from the preceding approaches in terms of the type of task description that is attempted. This approach (see Farina & Wheaton, 1973; Hackman, 1970) is predicated on a definition that treats the task as a set of conditions that elicit performance. These conditions are imposed on the individual and have an objective existence quite apart from the activities they may trigger, the processes they may call into play, or the abilities they may require. Having adopted this point of view, appropriate descriptive terms are those that focus on the task per se. The assumption is made that tasks can be described and differentiated in terms of intrinsic, objective properties they may possess. These properties or characteristics may pertain to the goal toward which the operator works, relevant task stimuli, instructions, procedures, or even to

characteristics of the response(s) or the task content. The obvious problem is the selection of those task components that are to be described, as well as the particular terms or parameters by means of which description is to be accomplished.

We have seen that tasks can be defined in several ways, particularly in regard to the scope of definition; the extent to which tasks may be treated as objective entities, clearly apart from the operators who perform them; and the extent to which tasks are viewed as processes or structures.

SOME METHODOLOGICAL ISSUES

Within the scope of this article I cannot dwell on the more general problems of "how" to proceed with classification. I shall discuss instead a number of criteria for evaluating such systems.

The requirement for operational definition of terms becomes increasingly critical if the system is to be used by a broad range of specialists. The descriptive terms may be completely unfamiliar to many of these individuals, or even too familiar as in the case of the popular terms *decision making* and *problem solving*. Although homage is paid to the need for operational definitions, few investigators have actually generated such definitions. Also, as a minimum requirement, the descriptors employed in the differentiation and classification of tasks must permit *nominal scaling*. That is, a judge must at least be able to ascertain whether each descriptor applies or does not apply to the particular task being examined.

Also, descriptors must be defined and treated within a system of measurement so that they can be reliably evaluated. Another criterion requires that classes within the system be mutually exclusive and exhaustive.

A major criterion is that classes are desired that have specific behavioral implications, as with the interest of Annett and Duncan (1967) in classifying "tasks" so that each category or class of tasks has specific training requirements associated with it. Ultimately, of course, any behavioral classification scheme must make the "match" between specific categories and behavioral effects. The degree to which the "match" can be made will determine the predictive power of the system. At one level, a statement might concern *whether or not* a particular environmental variable would affect performance. At another and more sophisticated level it might be possible to predict the *direction* and *magnitude* of the effect.

A final set of criteria includes efficiency and utility. The taxonomy should promote communication among its users, be they researchers in different areas or specialists who must use research findings in applied settings.

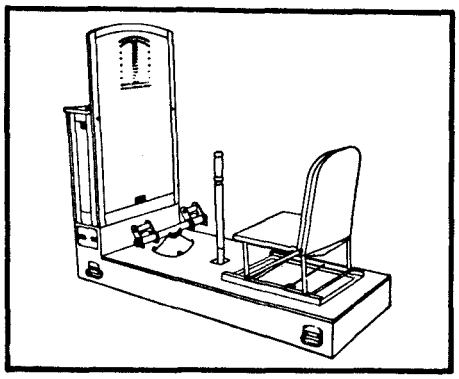
In our own program we found it useful to lay out these general issues, which we have elaborated elsewhere. In no sense can we say that our subsequent efforts met the rigorous standards called for. However, they at least provide indications of where we fell short and allow for successive iterations toward meeting these criteria.

In the remainder of this article, I illustrate some developments with two provisional systems, one based on the *ability requirements approach* and another on the *task characteristics approach*. I conclude with some attempts to link these two approaches.

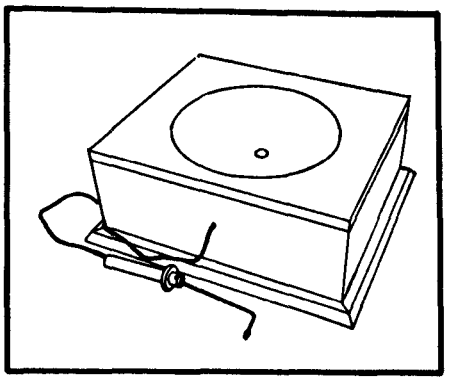
THE ABILITIES APPROACH

Much of what is known today about the categorization of human skills, at least that which is based on empirical research, comes from correlational and factor analysis studies. Such correlational studies are typically carried out in the psychometric tradition, and until recently, little attempt has been made to integrate the ability concepts developed there into the more general body of psychological theory. Here the fact of individual differences is exploited to gain insights about common processes required to perform different groups of tasks. Abilities are defined by empirically determined relations among observed separate performances.

FIGURE 1 Examples of Tests Found Valid for Pilot Selection



a. COMPLEX COORDINATION



b. ROTARY PURSUIT

It has been my feeling, over many years, that research using combinations of experimental and correlational methods, properly conducted, can lead to the development of a taxonomy of human performance which is applicable to a variety of basic and applied problems and that ability concepts may provide an integrative framework.

Elsewhere (e.g., Fleishman, 1962) I have elaborated on the concepts of *ability* and *skill.* Briefly, ability refers to a more general capacity of the individual, related to performance in a variety of human tasks. For example, the fact that spatial visualization has been found related to performance on such diverse tasks as aerial navigation, blueprint reading, and dentistry makes this ability somehow more basic.

My interest in this area began when I was responsible for developing psychomotor tests to select pilots for the Air Force. Figure 1a shows a test found valid for pilot selection. The test requires simultaneous manipulations of stick and rudder pedals and has a great deal of face validity. However, Figure 1b shows another test found equally valid. This test, the familiar pursuit rotor, has little face validity. The subject is required to keep a stylus tip in contact with a moving target. My feeling was that we needed basic research on the dimensions of perceptual-motor ability to identify what factors in these tests were common to the criterion performance in more complex tasks such as piloting.

An extensive series of interlocking experimental-factor-analytic studies, which we have conducted over many years, has attempted to isolate and identify the ability factors common to a wide range of perceptual-motor performances. Essentially, this is laboratory research in which tasks are specifically designed or selected to test certain hypotheses about the organization of abilities in a certain range of tasks. The experimental battery of tasks is administered to several hundred subjects, and the correlation patterns are examined through factor analysis methods. Subsequent studies tend to introduce task variations aimed at sharpening or limiting our ability factor definitions.

Through our investigation of a wide range of several hundred different tasks, we have been able to account for performance in terms of a relatively small number of abilities. The following display gives the labels of 11 perceptual-motor factors that consistently appear to account for the common variance in such tasks. In subsequent studies, definitions of these abilities and their distinctions from one another have become more clearly delineated. I will not define all of these here, but extensive

definitions of each ability exist with illustrations of the tasks that best measure them (Fleishman, 1964).

PERCEPTUAL-MOTOR ABILITIES

Control precision
Multilimb coordination
Response orientation
Reaction time
Speed of arm movement
Rate control (timing)
Manual dexterity
Finger dexterity
Arm-hand steadiness
Wrist-finger speed
Aiming

Similar studies have been carried out in the physical proficiency area, and nine factors have been identified that account for performance in several hundred physical performance tasks:

PHYSICAL PROFICIENCY ABILITIES

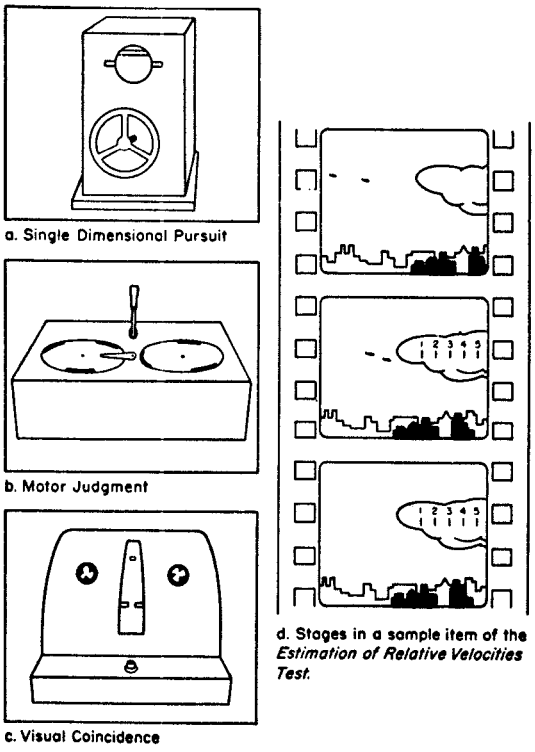
Extent flexibility
Dynamic flexibility
Static strength
Dynamic strength
Explosive strength
Trunk strength
Gross body coordination
Equilibrium
Stamina

Perhaps it might be useful to provide some examples of how one examines the generality of an ability category and how one defines its limits. The specification of an ability category is an arduous task. The definition of the rate control factor may provide an illustration.

In early studies it was found that this factor was common to compensatory tracking, for example, keep a horizontal line in the center of the dial, by compensatory movements of a control, as well as to following pursuit tasks, for example, keep a gun sight in line with a moving target (see Figure 2a). To test the generality of this factor, further tasks were developed to emphasize responses to stimuli moving at different rates, where the tasks were not conventional tracking tasks. For example, Figure 2b shows a task in which the subject had to *time* his movements in relation to different stimulus rates, but he did not have to follow a target or to compensate for the target's movement. The factor was found to extend to such tasks.

Later studies attempted to discover if emphasis on this ability is in judging the rate of the stimulus as distinguished from ability to

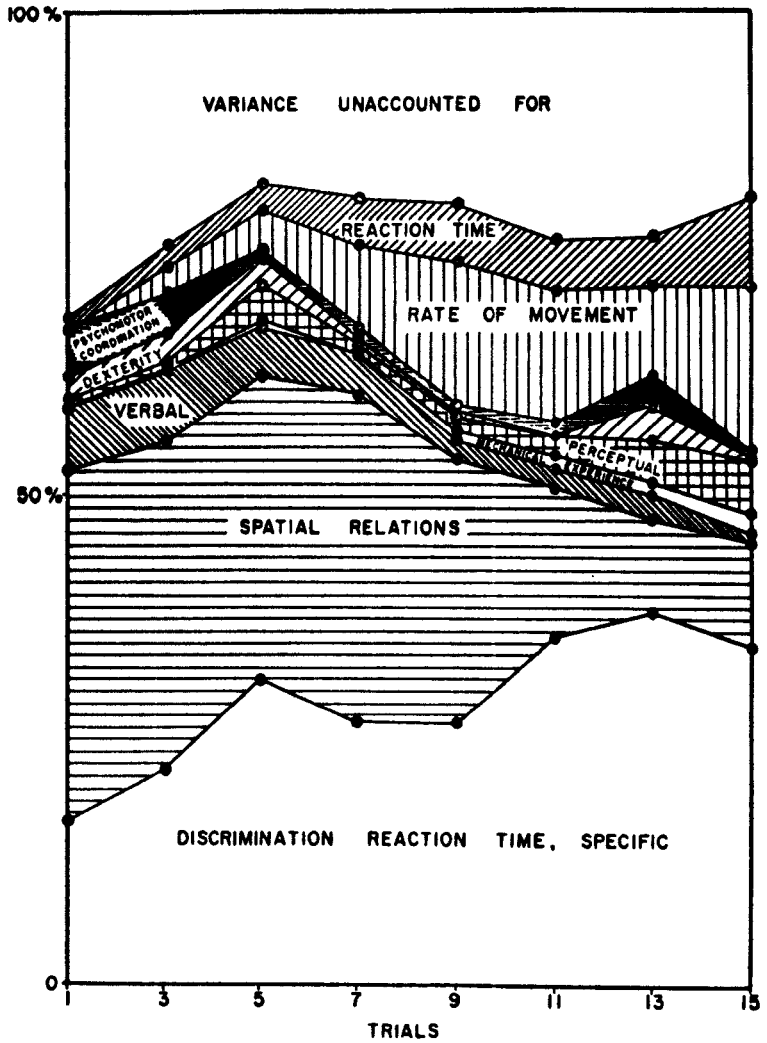
FIGURE 2 Examples of Tasks Used to Evaluate the Generality and Limitations of Rate Control Ability



Source: From "On the Relation Between Abilities, Learning, and Human Performance" by Edwin A. Fleishman, *American Psychologist*, 1972, *27*, 1017–1032. Copyright 1972 by the American Psychological Association. Reprinted by permission.

respond at the appropriate rate. Thus, Figure 2c shows a task developed where the only response was the timing of button pressing in response to judgments about the location of stimuli moving at different rates. Performance on this task did not correlate with other rate control tasks. Finally, several motion picture tasks, such as the one in Figure 2d, were adapted in which the subject was required to extrapolate the course of an airplane moving across a screen. The only response required was on an IBM answer sheet. (At what point did the planes meet? Points 1, 2, 3, 4, or 5?) These moving picture tests involving only judgments about stimulus rate did *not* correlate with the group of tasks previously found

FIGURE 3 Percentage of Variance Represented by Loadings on Each Factor at Different Stages of Practice on the Discrimination Reaction Time Task



Note: Percentage of variance is represented by the size of the shaded areas for each factor.

Source: From "The Relation Between Abilities and Improvement with Practice in a Visual Discrimination Reaction Task" by Edwin A. Fleishman and Walter E. Hempel, Jr., *Journal of Experimental Psychology*, 1955, *49*, 301–312. Copyright 1955 by the American Psychological Association. Reprinted by permission.