A DISCRIMINANT ANALYSIS OF PHYSICALLY IMPAIRED WORKER AND NON-IMPAIRED CO-WORKER PERFORMANCE IN A SELECTED DATA PROCESSING ENVIRONMENT

DISSERTATION

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The area of performance appraisal of the handicapped individual is a relatively uncharted domain. Previous studies have tended to either lump categories of handicaps together or to concentrate their performance appraisal on simplistic performance criteria. This dissertation focused upon the performance of a group of physically impaired workers and their non-impaired co-workers.

Central to this research endeavor was a comparison of the aggregate performances of both groups of workers through the use of parametric factor and discriminant techniques as well as the non-parametric sign test.

Performance scores for members of each group were derived from several behavioral variables: (1) collaboration; (2) credibility; (3) openness to influence; (4) constructive initiative; (5) priority setting; (6) formal communications; (7) organizational perspective; (8) flexibility; (9) thoroughness and accuracy; (10) work accomplishment;

and (11) decisiveness.

Findings of a discriminant analysis and a group applied sign test indicate that there is no significant difference, as reported by supervisors, in the overall performance level of similarly placed impaired workers and their non-impaired co-workers. On inspection of individual variables with the aid of the sign test and a later discriminant study, a significant performance difference between the two groups on five behavioral variables was noticed. Of these differences, the direction of the level of performance was favorable to the impaired group of workers on two of the five behavioral items.

Based on overall levels of performance, this research effort found no evidence that there are differences in the performance of equally placed impaired workers and their non-impaired co-workers. This research has shown that at certain specific levels of performance evaluation, significant differences do exist between the performance level of the impaired and non-impaired workers. However, the differences suggest that the two groups have certain strengths over one another that are desirable to both groups of workers. This information could therefore be used in employee training efforts to raise the total performance level of all workers.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF ILLUSTRATIONS

CHAPTER I

INTRODUCTION

Background

The area of performance appraisal of the handicapped individual is a relatively uncharted domain. Previous studies have tended either to lump categories of handicaps together or to concentrate their performance appraisal on simplistic performance criteria such as absenteeism.[1] Still other researchers seem to pay greater attention to the mentally impaired and their ability to function within society rather than concentrating on the training, placement and appraisal of the mentally capable, physically impaired individual.[2]

Within the previous decade, emphasis on increasing

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[1]Henry S. Hammond, The Performance of Physically Impaired Workers in Manufacturing Industries, United States Bureau of Labor Statistics, Bulletin No. 923 (1948).

[2]G. T. Bellamy, R. H. Horner, and D. P. Inman, Vocational Habilitation of Severely Retarded Adults (Baltimore: University Park Press, 1979); D. E. Brolin, Vocational Preparation of Retarded Citizens (Columbus, Ohio: Charles E. Merrill), 1979; D. Huddle, "Work Performance of Trainable Adults as Influenced by Competition, Cooperation and Monetary Reward," American Journal on Mental Deficiency, (1967), 72; 198-211; F. R. Rusch and D. E. Mithaug, Vocational Training for Mentally Retarded Adults, (Champaign, Ill.: Research Press, 1979); F. R. Rusch, R. P. Schultz, D. S. Lamson, and B. M. Menchetti, "Vocational Training and Employment Program: Interim Report," Department of Special Education, College of Education, University of Illinois, Urbana, Illinois, 1979.

the effectiveness of performance appraisal systems has increased. With the growing acceptance of MBO programs and their variants, performance appraisal methodology has become refined.[3]

It seems appropriate, then, that research regarding the performance appraisal of the often-overlooked, mentally-capable, physically impaired worker should be undertaken. This research should begin with the exploration of the performance of a group of physically impaired workers and their non-impaired co-workers.

The importance of the problem

In today's rapidly changing economic environment, business practitioners are charged with a new sense of the necessity to conserve system resources. A recent periodical goes so far as to point out that in the face of dwindling natural raw materials, certain U.S. firms have been stockpiling a technological arsenal devoted to synthesizing new materials.[4] This search for new, capable resources is not limited to raw materials either. Since the Great Depression and World War II, America has heightened its investment in the greatest and most valuable of our possessions, the conservation of human resources.

The war years forced the nation to bring together

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[3]R. Randall Hofman, "MJS: Management by Job Standards," Personnel Journal (August 1979): 536-40+.

[4]Henry DeYoung, "Chemical Producers Look Beyond Petroleum," High Technology, April 1982, pp. 57-63.

all of her resources, both human and material, to achieve a common goal of national defense. The resultant necessary inventory of resources uncovered many disappointments, one being the evident waste of our human resources. Rusk and Taylor amplify this part of America's history.

> Of the twenty million men examined for the draft, nearly one-third were found unfit for military service. Over three-quarters of a million of these men had gross physical defects such as amputations, blindness, deafness, and a congenitally short leg, clubfoot or a withered arm--disabilities for which they required intensive rehabilitation. In spite of the careful screening of the draft, it was necessary that nearly a million men, most of whom had served less than a year, be discharged from the service.[5]

How did America confront this issue? Henry Kessler provides insight to our national policy at the time.

> We met the problem in our usual pragmatic way by selecting our so-called physically fit for military service, and relegating the unfit, the 4Fs, to a position alongside the women (who have always been regarded as physically inferior) and the superannuated, to man the defense factories and carry on the battle of production. The record of production achieved by these apparently substandard groups is now history. How did they accomplish it in the face of our usual concept of physical fitness?
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> Sober analysis reveals the basic error of our thinking. It is necessary to reexamine the whole concept of physical fitness not as a mere semantic exercise, but as a term of great significance. It refers not only to the physical fitness of the soldier, sailor, or marine, to perform military service, but the ability of the worker to perform productive and continuous work. It is a term with many political and economic overtones. It is a key word to the correct understanding of the whole problem of the crippled and disabled. False concepts of physical fitness have had an important influence on our civil, industrial, and

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[5]Howard A. Rusk, M. D. Taylor and Eugene J. Taylor, New Hope for the Handicapped (New York: Harper & Brothers Publishers, 1949), p. ix.

> military life. Vague standards have been created that have condemned those with physical defects as unproductive and socially useless. Excessive import has been given to psychologic and aptitude tests in the determination of physical fitness, while human energy and capacity have in general been largely underestimated.[6]

The need to make the fullest use of our manpower resource is as necessary today as it was during the crisis time of war. The challenge to do so is herald in numerous popular books, newspapers, magazines and trade journals with such titles as "Can America Reindustralize," "Japan, Inc.," and "The Third Wave." The capacity of the physically impaired worker, as was demonstrated during the war effort, lead us now to realize that there need be no such thing as a "human scrap heap."[7]

By investigating the performance of a group of physically impaired workers and their non-impaired co-workers, it is hoped that a level of work achievement of the the two groups can be assessed.

Available strategies

Management has always placed a high degree of attention to the ability of its workers. Numerous measures of worker effectiveness and productivity have surfaced. However, these measures have been almost exclusively applied to non-impaired workers. The ability of their physically

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[6]Henry H. Kessler, Rehabilitation of the Physically Handicapped, (New York: Columbia University Press, 1953), pp. 3-4.

[7]Howard A. Rusk, M. D. Taylor and Eugene J. Taylor, New Hope for the Handicapped (New York: Harper & Brothers Publishers, 1949), p. x.

impaired counterparts has, according to some, been largely a matter of being able to perform tasks within the realm of safety.[8] This has led to measures concerning the physically-impaired worker to be scarcely more than simple tabulations of products produced, or an accounting of surface variables like the number of accidents involved in, or attendance. An example of the focus of early studies on these type of variables is reported in table 1 from a survey of more than 100 employers made by the Office of Vocational Rehabilitation, Federal Security Agency.

TABLE 1

PERCENTAGE OF EMPLOYERS REPORTING

Subject	Lower for Handicapped	Same in Both Groups	Higher for Handicapped
Absenteeism	55	40	5
Labor turnover. . .	83	16	1
Accident rate . . .	57	41	2
Productivity. . . .	10	66	24

Source: Clark D. Bridges, Job Placement of the Physically Handicapped, (New York: McGraw-Hill, 1946), pp. 5.

A search of the literature reveals studies in two major areas:

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[8]Henry H. Kessler, Rehabilitation of the Physically Handicapped (New York: Columbia University Press, 1953), p. 4.

1. Early studies consisting, for the most part, of simplistic reporting of surface variables like "accident rate"

2. Later, more quantitative models for job classification and performance evaluation systems

The work in each of these areas is reviewed in chapter 2. However, no studies were located which attempt to assess the level of work achievement of a group of physically impaired workers and their non-impaired co-workers.

Research Objectives

This research proposes to explore the performance of physically impaired workers and their non-impaired co-workers in a selected data processing environment. A comparison of the aggregate performance of both groups will be made using factor and discriminant techniques.

Subproblems

First subproblem. The first subproblem is to determine whether physically impaired workers, who have received job-related training prior to placement in a data processing environment, have performance levels different than their non-impaired co-workers.

Second subproblem. The second subproblem is to select or construct a performance level measurement device that is appropriate to both the physically impaired and non-impaired workers.

Third subproblem. The third subproblem is to differentiate the performance of the physically impaired workers and the performance of non-impaired co-workers in a similar data processing environment. This will be done through the use of the performance measurement device.

Fourth subproblem. The fourth subproblem is to analyze and to interpret the data so as to evaluate the performance outcomes of the two groups.

Hypothesis

Central to this research endeavor was a comparison of the aggregate performances of both groups of workers through the use of factor and discriminant techniques. Data was collected to test the null hypothesis:

H_0 There is no significant difference between the performance levels of the two groups.

Performance scores for members of each group were derived from several behavioral variables: (1) collaboration; (2) credibility; (3) openness to influence; (4) constructive initiative; (5) priority setting; (6) formal communications; (7) organizational perspective; (8) flexibility; (9) thoroughness and accuracy; (10) work accomplishment; and (11) decisiveness.

Delimitations

In order to more closely focus the attention of this research on the area of performance, and to comply with

certain sections of the Privacy Act,[9] the following limitations are necessary:

1. The study does not attempt to predict success of the physically impaired workers who have received job-related-training prior to job placement, or the success of their non-impaired co-workers

2. The study does not evaluate the training and/or preparation of the workers

3. The study is limited to the employed impaired graduates of a member institution of the Association of Rehabilitation Programs in Data Processing (ARPDP), their non-impaired co-workers and immediate supervisors

4. The study does not attempt to evaluate whether discrimination toward employees, in general, exists

5. No attempt has been made to distinguish performance levels with a certain discrete class of handicap

6. The study does not identify certain demographic characteristics such as age, sex, or ethnic background, nor has an attempt been made to explain levels of performance on the basis of these characteristics.

Definition of terms

Physically impaired worker. For the purpose of this study, a physically impaired worker is a professional employee who has a physical impairment (walking, seeing, hearing, or speaking) which substantially limits his or her

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[9] Privacy Act, Public Law 95-38, Statues at Large 91 (1977).

ability to work; this person is also a graduate of one of the member institutions of the Association of Rehabilitation Programs in Data Processing (ARPDP).

Non-impaired co-worker. A non-impaired co-worker is a professional employee who is engaged in a similar set of job duties in the same data processing environment with one or more of the physically impaired workers described above.

Data processing environment. A data processing environment is any workplace in which the primary activities are in direct contact with or in support of automated data processing machinery.

Abbreviations

ARPDP is the abbreviation used for the Association of Rehabilitation Programs in Data Processing.

PDQ is the abbreviation used for the Performance Description Questionnaire.

TDM is the abbreviation used for the Total Design Method.

Methodology

Selection of worker environment

The data processing industry was selected as the source of data for this research effort for the following reasons:

Available training programs. Contact with the Association of Rehabilitation Programs in Data Processing (ARPDP), provided a number of employed severely physically

handicapped individuals trained as computer programmers. These individuals worked in numerous large, medium and small firms throughout America, side-by-side with non-impaired co-workers. The level of training received by the physically impaired members of this study is covered in greater detail in chapter 3.

Limited job classes. Since the types of work being evaluated were so similar, the homgeneity of the data was enhanced. All the performance evaluations centered around individuals of equal job content within the relatively narrow confines of a normally functioning data processing department. A large number of the evaluations were on like workers having an entry or slightly higher level of programming skill.

Accessibility. The gracious cooperation of the ARPDP and their provision of lists of graduates, along with their home and business addresses, greatly eased the data gathering portion of this study. Queries of the graduates allowed for the construction of a supervisory mailing list that formed the basis for the responses used in this study.

Technological implications. The rapid growth of the data processing industry and its associated thirst for qualified personnel represent a challenge for America. It seems a strange repetition of history that this new, rapidly advancing field is looking to the country's forgotten workers in the same manner brought on by the crisis of war. The nature of the technologically advanced workplace might in-

deed have adequate room for performance without regard to individual physical barriers. This unique cross-section of firm size, technological leadership, diverse geographical location, and equal worker duties and responsibilities seemed a tailored environment to the research questions.

Writer's experience. The researcher is familiar with data processing activities. Having worked in the field for some nine years, spanning a varied exposure to automated technology and data processing skills has added to this investigation. Presently, the researcher is involved in a number of associated data processing activites involving specifying mini- and micro-computer systems and the necessary manpower resources to aid in the solution of various client's problems.

Questionnaire development

The questionnaire used in this study examines the level of worker performance of a physically impaired graduate of the ARPDP and his/her non-impaired co-worker. In fact, two questionnaires were employed; (1) one to secure permission from graduates of the participating ARPDP facilities to approach their immediate supervisors, and (2) one directed to the supervisor of the physically impaired worker. The questionnaires and cover letters are in appendices 1 and 2.

Behavioral categories. The supervisors responded to questions regarding the performance of the workers reflect-

ing eleven behavioral categories. In all, the forty-three items contained on the instrument that deal with individual employee performance that form these eleven behavioral classes are referred to as "performance dimensions".[10] This instrument provides behavioral information in the following areas of worker performance:

1. Collaboration
2. Credibility
3. Openness to influence
4. Constructive initiative
5. Priority setting
6. Formal communications
7. Organizational perspective
8. Flexibility
9. Thoroughness and accuracy
10. Work accomplishment
11. Decisiveness

Each supervisor indicated the extent to which they agreed that the statement reflected the subordinates behavior on a six point Likert scale. The method of analysis of the resulting data is explained in chapter 4.

Data analysis

The analysis of the data will be accomplished in three steps:

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[10]Michael Beer et al., "A Performance Management System: Research, Design, Introduction and Evaluation," Personnel Psychology 31 (1978):513.

1. Factor analysis of both sets of variables (the performance evaluations of the impaired and non-impaired individuals)

2. A sign test of each variable as well as on an overall performance composite

3. A discriminant classification of the two groups

Reliability. Due to fact that the ratings collected in this study reflect performance appraisals from only one supervisor, instead of two or three for each worker, using the intraclass correlation statistic suggested by Ebel[11] for estimating test reliability was not possible. However, the communality (h^2), the sum of all the common factor variance of a test, which is reported in the factor analysis portion of this study provides an indication of the reliabilty of the test. Remembering that total variance of a test is comprised of common variance and unique variance, and that the unique variance is the sum of specific and error variance, a general assessment of unrelaibilty can be made.

If the total variance of the test was made equal to one (a condition of each individual test in a factor analysis), the amount of unique variance is easily calculated as follows:[12]

$$1 - \text{communality } (h^2) = \text{unique variance}$$

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[11]Robert L. Ebel, "Estimation of the Reliability of Ratings," Psychometrika 16 (December 1951):407-24.

[12]Dennis Child, The Essentials of Factor Analysis (London: Holt, Rinehart and Winston, 1970-75), p. 42.

If the communality is low, resulting in a value of 0.7 or more for the unique variance component, it could mean that the test is unreliable. Since the unique variance is the sum of specific and error variance, it is possible that the latter could be making the major contribution. Communality values are reported in chapter 4, and because they are relatively high it could indicate that the degree of unreliability associated with this study is low.

A detail of the techniques, and the analysis and interpretation of results, are contained in chapter 4. A summary and discussion of the contribution of this research comprise chapter 5.

CHAPTER II

THE REVIEW OF THE RELATED LITERATURE

The related literature can be classified into three categories: (1) historical overview, (2) the early qualitative studies, and (3) the later quantitative studies. The available literature provided contributions to this dissertation in the following manner: (1) the historical overview supplied a philosophical foundation of civilizations view of the physically impaired individual; (2) the qualitative studies offered a necessary legislative perspective and the development of subjective measures of cost associated with the handicapped worker; and (3) the quantitative studies formed the necessary framework for questionnaire development and research methodology.

Historical Overview

Greek view

Interests in the well-being of the handicapped individual have in the past been virtually non-existent. Early Roman and Greek philosophy hail the doctrine of the "survival of the fittest", thereby rejecting the not-so-fit. Plato indicates the Greek characterization of the philosophy when he states:

> . . . the offspring of the inferior, or of the better when they chance to be deformed, will be put away in

some mysterious, unknown place, as they should be.[13]

Early religious view

Although this seems somewhat harsh, this attitude prevailed until the Middle Ages, when religious sects such as St. Vincent de Paul's Sisters of Charity became aware of the needs of the handicapped individual and responded by establishing homes and asylums for their protection.[14] Mithaug states that:

> . . . During the Protestant Reformation, . . . some groups regarded the handicapped as "filled with the Devil." It was not until the turn of the nineteenth century, when the philosophies of the American Revolution and the French Revolution - democracy, egalitarianism, and the rights of the individual - came of age, that new hope of the handicapped emerged. . . . In the mid-1800s, New York, Pennsylvania, and Ohio established state institutions for the education and training of handicapped persons who would subsequently return as average citizens to the community.[15]

Legal view

Despite much optimism regarding this last effort, funding and anticipated levels of care were underestimated. By the 1900s, institutional programs were once again more closely custodial facilities than they were training centers.

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[13]Plato, Republic, Book V., trans. B. Jowett, (New York: Random House, 1941).

[14]Dennis E. Mithaug, "The Changing Workforce: An Introduction," Journal of Contemporary Business 8 (1978): 1-4.

[15]Ibid.

However, court challenges, stimulated from a number of parent advocacy groups formed in the 1950s, did result in a series of affirmations of the constitutional rights of all citizens.[16] These court cases established the precedent for passage of the Education for All Handicapped Children Act (PL 94-142) which assures that all handicapped children have available to them free appropriate public education.

This piece of legislation coupled with the Rehabilitation Act of 1973 extends the protection of the rights of the handicapped individual into adulthood, hopefully culminating in the successful search for employment and an independent, self-sufficient career. Section 504 of the Rehabilitation Act of 1973 states that:

> No otherwise qualified handicapped individual . . . shall, solely by reason of his handicap, be excluded from the participation in, be denied the benefits of, or be subjected to discrimination under any program or activity receiving Federal financial assistance.[17]

However, saying what should be, does not always make it so; one cannot legislate opportunity. Employers must reject myths regarding all types of employees and select and promote on the basis of performance and equity.

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[16]Brown v. Board of Education, 347 U.S. 483 (1954); Diana v. State of Education of California, C-70 337 RFP, District of Northern California, 1970.; Hobson v. Hansen, 393 U. S. 801 (1968); Mills v. Board of Education of District of Columbia, 384F. Supp. 886 (D.D.C., 1972); Pennsylvania Association for Retarded Children v. Commonwealth of Pennsylvania, 334 F. Supp. 1257 (E.D. Ua., 1971).

[17]Rehabilitation Act, Public Law 93-112, Statues at Large, 87 (1973).

Early Qualitative Studies

The physically impaired worker

In a 1975 report by the Urban Institute for the U.S. Department of Health, Education, and Welfare, it was concluded that one out of every five Americans in the 18-64 age bracket within the non-institutional population, is disabled.[18] This translates into the fact that approximately 25 million Americans, or almost 20 percent of the country's non-institutionalized adult population are unable to either hear, see, walk, to talk normally, or to attend school or enter the job market, as easily as the remaining population. Peter M. Jamero tells us that:

> Most disabled persons who are employed are engaged in what economists have called the "secondary labor market."
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> . . . . . .
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> Problems of the unemployment and underemployment among the handicapped are not likely to diminish in the foreseeable future, despite remarkable advances in medical care, technology, rehabilitation, modification of architectural barriers, and job placements. The costs to the country through the failure to utilize a valuable human resource is incalculable. Such costs will continue to be borne by the entire nation as a whole unless there is a significant turnaround from the country's institutions.[19]

The subject of costs, and supervisor opinions and attitudes have been the basis for several research efforts. Among the opinions found were these:

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[18]Urban Institute, "Comprehensive Needs Study of Severely Disabled Individuals," Washington, D.C., 1975.

[19]Peter M. Jerome, "Handicapped Individuals in The Changing Workforce," Journal of Contemporary Business 8 (1979): 34-35.

1. Handicapped persons are not occupationally mobile and thus are not flexible enough for careers development
2. Health and good appearance of all workers are of prime importance
3. Top management staff must be in top mental and physical condition
4. It is difficult to find jobs that disabled persons can do or be trained to perform[20]

Department of Labor study

Regarding the issue of costs, there exist two studies which, at first glance, lay to rest the notion of increased organizational costs as a result of employing the physically impaired. The first of these was a 1948 study conducted by the Department of Labor.[21] This nationwide study compared employment records of over eleven thousand disabled workers, selected on the basis of sex, age, occupation, firms, and specific job assignment. The study concluded that there was no significant difference between disabled and non-disabled workers regarding employee production, on-the-job injuries, absenteeism, or in voluntary terminations.[22] Unfortunately, the DOL study was short in statistical rigor. Most of its findings were reported as simple frequencies or tabulations, with an occasional

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[20]Ibid., pg. 36.

[21]U. S. Department of Labor. "The Performance of Physically Impaired Workers in Manufacturing Industries." Washington, D.C., 1948.

[22]Frank Bowe, Handicapping America: Barriers to Disabled People (New York: Harper and Row, 1978), pp. 177-78.

calculation of an average rate of occurrence. In some instances, it is indicated that overall performance of the impaired individual was slightly higher than that of the non-impaired workers.[23] However, the age of the study is perhaps its worst enemy. Approximately one-third of its survey group were physically impaired as a result of a hernia, and almost three-quarters of the survey group's occupation was classified as either of a maintenance or processing nature. Clearly, thirty years has seen advancement in medical techniques and general upward occupational movement within the American work environment. It is only fair to conclude that one cannot base today's attitudes regarding the performance of the physically impaired worker on such evidence as is supplied by the DOL study.

The DuPont study

E. I. DuPont de Nemours conducted an eight month study in 1973, collecting data on its 1,452 disabled employees.[24] The DuPont study tabulated results in seven critical areas and reportedly debunked the major myths about disabled employees by producing these findings:

1. Insurance: no increases in compensation costs nor lost-time injuries

2. Physical Modification: minimal with most disabled

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[23]U. S. Department of Labor. "The Performance of Physically Impaired Workers in Manufacturing Industries." Washington, D.C., 1948, pg. 52.

[24]"Firms Get Their Money's Worth By Hiring Disabled Employees," Commerce Today, 29 (September 1975), pp. 8-9.

employees requiring no special work assignment

3. Safety: 96 percent of handicapped workers rated average or better, both on and off the jobs, with more than half above average

4. Special Privileges: disabled employees want to be treated the same as other employees, and other employees do not resent what privileges they do have (e.g., parking close to the building)

5. Job Performance: 91 percent rated average or better when compared with the general work force

6. Job Stability: 93 percent average or better

7. Attendance: 79 percent rated average or better[25]

Although the DuPont study, and others have demonstrated that disabled employees are more reliable and stable than their non-disabled counterparts, are their findings accurate? Julie and Paul Wysocki state that such findings:

> . . . are partially due to past discriminatory practices. That is, because many disabled people experience difficulty if not outright discrimination in securing employment, they value a job once they obtain one and subsequently feel less independent and mobile in the work than do the nondisabled.[26]

However, in view of the survey and interview techniques employed in these various studies, and the absence of the use of a more competent performance appraisal approach, it seems that rather than providing accurate information, another instance of Halo effect has emerged regarding the mentally capable physically impaired workers.

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[25]Ibid.

[26]Julie Wysocki and Paul Wysocki. "An Employer's Guide to Employment and Disability," Journal of Contemporary Business 8 (1979): 64.

Later Quantitative Studies

The performance appraisal systems

The evaluation of human performance is a central issue to all workers and the organizations of which they are members. This is indicated by the current vast amount of literature concerned with the measurement of worker effectiveness. Within this discipline, there is agreement on the need of all organizations to develop and maintain an unbiased performance appraisal system. William I. Sauser, Jr. provides an adequate summary:

> . . . a properly constructed and maintained performance appraisal system can contribute to employee effectiveness by providing feedback about specific strengths and weaknesses, documenting the fairness of administrative personnel decisions, providing information to guide employee training, development, and placement programs, and enhancing feelings of responsibility on the jobs. Since organizational effectiveness is strongly influenced by individual effectiveness, it is obvious that a good performance appraisal system can improve the overall effectiveness of the organization.[27]

Although researchers and practitioners agree on the need and importance of a performance measurement system, their pursuit of "the" system has resulted in the availability of hundreds of specific techniques used to measure employee performance. Patricia Smith has effectively argued that there are two categories of data which are available:

> The "hard" criteria obtained from organizational records . . . and the "soft" criteria obtained from performance

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[27]William I. Sauser. "Evaluating Employee Performance: Needs, Problems and Possible Solutions." Public Personnel Management (January, 1980): 13.

ratings.[28]

Unfortunately, centuries of experience with both types of criteria have taught us that neither alternative is free from bias and distortion.[29] However, several relatively new advances offer promise to those seeking an effective performance appraisal method.

Management by objectives

The most recent techniques of performance appraisal center around the Management by Objectives (MBO) technique of supervision. The MBO system offers distinct advantages in harmonizing corporate and individual goals and it provides a meaningful feedback and evaluation system when goal and objective accomplishment are measurable. MBO has become popular due to its ability to remove a large portion of the adversity confronting a supervisor surrounding the performance appraisal. It accomplishes that by directing the supervisor's (or rater's) attention exclusively toward the results of a task and away from the situation where a superior must make judgements concerning the personal attributes of the subordinate. As McGregor (1957) argued, to ask someone to judge the personal worth of another individual is

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[28]P. C. Smith. "Behaviors, Results, and Organizational Effectiveness: The Problem of Criteria," In M. D. Dunnette (Ed.), Handbook of Industrial and Organizational Psychology (Chicago: Rand-McNally, 1976), pg. 753.

[29]A personnel rating form having much in common with some forms employed today was in use 190 years ago, according to W. R. Mobler. Twenty Years of Merit Rating: 1926-1946 (New York: The Psychological Corporation, 1947).

incompatible with egalitarian ideas.[30] Robert A. Ruh provides the reasons why MBO systems have been so popular:

1. MBO, with its task-orientation is more impersonal

2. MBO has to do with the relatively low level of analytical skill managers possess with regard to individual behavior

3. Some managers are so results-oriented that they feel they do not have time for any of that "personal stuff"[31]

Ruh continues,

> Thus, any system which focuses their attention entirely on task results is more heavily favored. MBO may be very popular because it makes the performance review process, the feedback of performance results, a little less threatening or a little less emotionally difficult for the boss . . . There is some research supporting MBO as a very useful vehicle for affecting the quality of supervisor - subordinate relationships (Carroll and Tosi, 1970) as well as need satisfactions of managers (Ivancevich, Donnelly and Lyon, 1970). In addition, there is research indicating that the goal-setting process itself has motivational effects and practical merits. It is necessary as a means of stimulating motivation and managing task accomplishment.[32]

However, Management by Objectives is not a panacea. Since it focuses attention exclusively on the results of tasks which accomplish objectives, its major strength is also its major weakness.[33] Significant behavioral or personal quali-

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[30]D. McGregor. "An Uneasy Look at Performance Appraisal," Harvard Business Review 43 (1965): pg. 89-94.

[31]Michael Beer, et al. "A Performance Management System: Research, Design, Introduction and Evaluation." Personnel Psychology 31 (1978): pg. 519.

[32]Ibid.

[33]Michael Beer and Robert A. Rich, "Employees Growth Through Performance Management," Harvard Business Review (July 1976): pg. 55-56.

fications can frequently be overlooked in an MBO system, particularly when they were not originally defined as an explicit objective.[34] While such a system can be beneficial, there are still quantifiable needs to be fulfilled.

The biographical questionnaire

W. A. Owens laid the groundwork of a conceptual model for biodata research in classifying persons.[35] This framework included the 659-item Biographical Questionnaire (BQ) that covered a broad spectrum of prior experiences. The biographical information covered such areas as family life, school-related activities, religious activities, interests and attitudes derived from life experiences, sports participation, and extrafamilial relationships.[36]

Factor analysis reduced the number of items on the final version of the BQ with the resultant factor structure, (15 female factors, and 13 male factors) being used in a classification process. The biodata factors were used to classify male and female subjects within the prior experiences spectrum. This approach served to provide a necessary background for the development of a methodology that was

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[34]Melvin E. Shick, "The 'Refined' Performance Evaluation Monitoring System: Best of Both Worlds," Personnel Journal (January 1980): pg. 47-50.

[35]Bruce J. Eberhardt and Paul M. Muchinsky "An Empirical Investigation of the Factor Stability of Owens' Biographical Questionnaire," Journal of Applied Psychology 67 (1982): pg. 138.

[36]Ibid.

eventually adopted for use in the study being reported.

The performance management system

Michael Beer, et al, being aware of MBO's uselessness of improving subordinates' ability to perform effectively due to its inability to provide diagnostic information about why an individual is not performing, have developed the Performance Development and Review (PD&R) System (Figure 1).[37] This system was designed to provide needed data about personal skills and behaviors in making promotion decisions while overcoming some of the difficulties inherent in person oriented rating systems including low validity, unreliability, halo effect and leniency.[38]

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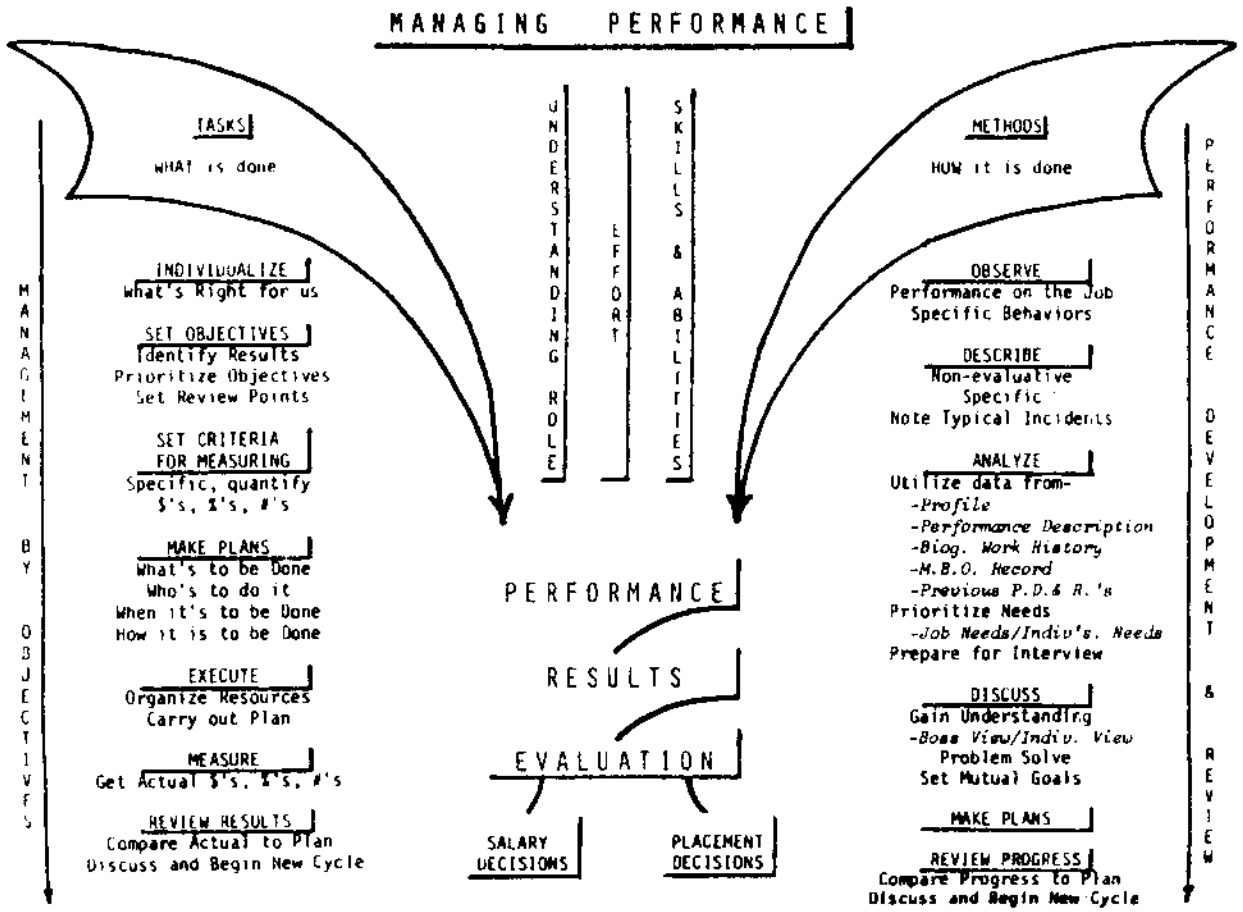
[37]Michael Beer, et al. "A Performance Management System: Research, Design, Introduction and Evaluation." Personnel Psychology 31 (1978): pg. 520.

[38]Ibid.

FIGURE 1.



Source: Michael Beer, et al. "A Performance Measurement System: Research, Design, Introduction and Evaluation." Personnel Psychology 31 (1978): 518, Figure 1.

Essentially, the PD&R System is comprised of the following:

1. The system uses observable behaviors as the basis for managerial judgements about a subordinate--freeing it from typical rating scale problems

2. A forced observation of the behavior of subordinates by the superior as a result of 76 specific "behavior" items on a questionnaire. This approach dictates that the superior must maintain some sort of record of "critical inci-

dents" as described by Flanigan[39]

3. A subordinate performance analysis aid to the managers through the "performance profile"[40]

This ipsative profile has merit as a development function since it is a graphical display of the subordinates strengths and weaknesses expressed as a deviation from a centerline representing the subordinate's own mean behavior.

However, of most importance to this research effort is the development of the "Performance Description Questionnaire" used as the assessment device for individual performance and the possibility of obtaining an overall performance score from the supervisory ratings.[41]

Cognitive complexity and the appraisal process

In 1977, C. E. Schneier conducted an exploratory study that supported a cognitive compatibility theory of performance appraisal.[42] The theory of cognitive compatibility proposes that the compatibility of the rater cognitive structure with the cognitive demands made by the rating format may be crucial in performance appraisal. To the

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[39]J. C. Flanigan, "A New Approach to Evaluating Personnel," Personnel 26 (1949): pg. 35-42.

[40]Michael Beer, et al. "A Performance Management System: Research, Design, Introduction and Evaluation." Personnel Psychology 31 (1978): pg. 521.

[41]Ibid., pg. 513.

[42]C. E. Schneier, "Operational Utility and Psychometric Characteristics of Behavioral Expectation Scales: A Cognitive Reinterpretation," Organizational Behavior and Human Performance 62 (1977): pg. 541-48.

degree that compatibility exists, there will be an increase in the psychometric quality of the resultant ratings.

C. E. Schneier defined cognitive complexity as "the degree to which a person possesses the ability to perceive behavior in a multidimensional manner".[43] J. Bieri, et al, explains cognitive complexity and simplicity in the following statement:

> A cognitively complex person has a relatively differentiated system of dimensions for perceiving the behavior of others, whereas a cognitively simple person has a relatively undifferentiated system of dimensions for perceiving the behavior of others.[44]

In terms of the rating format choice, Schneier defined a "complex" rating format as one that requires many specific judgements and fine discriminations in the perception of complex and numerous job behaviors. In addition, he stated that the use of behavior anchors on a scale creates difficulty for cognitively simple raters.

Incorporating a behaviorally anchored rating scale (BARS) as the complex format and a more simple format, the 1977 Schneier study concluded that cognitively complex raters preferred and were more confident in their ratings with the BARS, whereas the cognitively simple raters preferred the more simple format. Also, the cognitively complex raters made ratings with less leniency and restriction of range errors with BARS than did the simple

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[43]Ibid., pg. 541.

[44]J. Bieri, et al. Clinical and Social Judgment (New York: Wiley, 1966).

raters. Additionally, complex raters also exhibited less halo error than simple raters with either type of rating format. Schneier suggested that further research was necessary to establish the interactive relationship between cognitive structure and appraisal format found in his exploratory investigation.

Recent reviews. Certain recent reviews in the area of performance appraisal have cited the importance of the cognitive complexity of raters in the appraisal process.[45] All have discussed the predictive power of cognitive complexity with respect to appraisal effectiveness. In the latest review of behaviorally anchored rating scales, Jacobs, Kafry, and Zedeck concluded that:

> . . . cognitive complexity is one property of the rater which relates to effective performance evaluation.[46]

In another recent article discussing performance appraisal, J. M. Feldman suggested the importance of cognitive complexity.[47] However, all of these reviews seem to rely on "one-

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[45]F. Landy and J. Farr, "Performance Rating," Psychological Bulletin 87 (1980): pg. 72-107; M. D. Dunnette and W. C. Borman, "Personnel Selection and Classification Systems," Annual Review of Psychology 30 (1979): pg. 477-525; J. S. Kane and E. E. Lawler, III., "Performance Appraisal Effectiveness: Its Assessment and Determinants," In B. Staw (Ed.), Research In Organizational Behavior 60 (1975): pg. 695-703; T. Decotiis and A. Petit, "The Performance Appraisal Process: A Model and Some Testable Propositions," Academy of Management Review 3 (1978): pg. 634-46.

[46]R. Jacobs, D. Kafry, and S. Zedeck, "Expectations of Behaviorally Anchored Rating Scales," Personnel Psychology 33 (1980): pg. 595-640.

[47]J. M. Feldman, "Beyond Attribution Theory: Cognitive Processes in Performance Appraisal," Journal of Ap-

shot" validation approaches that have not been widely accepted.

Empirical studies. In a series of empirical investigations of Schneier's cognitive compatibility theory, no support for the theory has been found, despite the fact that all of the studies used BARS requiring similar numbers of discriminations on rating formats as did Schneier.[48] A discussion of these studies may be found in Bernardin and Cardy (1981).[49]

A 1982 investigation by Bernardin, Cardy, and Carlyle reexamined the role of cognitive complexity as a predictor of appraisal effectiveness.[50] The results of this effort lead one to seriously question the validity of cognitive compatibility theory. However, certain results point to the possibility of the importance of the complexity of a

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plied Psychology 66 (1981): pg. 127-48.

[48]W. C. Borman, "Individual Difference Correlates of Accuracy in Evaluating Others' Performance Effectiveness," Applied Psychological Measurements 3 (1979): pg. 103-15; M. A. Lahey and F. E. Saul, "Evidence Incompatible With A Cognitive Compatibility Theory of Rating Behavior," Journal of Applied Psychology 6 (1981): pg. 706-15; W. I. Sauser and S. B. Pond, "Effects of Rater Training and Participation on Cognitive Complexity: An Exploration of Schneier's Cognitive Reinterpretation," Personnel Psychology 34 (1981): pg. 563-77.

[49]H. J. Bernardin and R. L. Cardy, "Cognitive Complexity in Performance Appraisal: It Makes No Nevermind," Proceedings of the 41st Annual Meeting of the Academy of Management 16 (1981): pg. 306-10.

[50]H. J. Bernardin, R. L. Cardy, and J. J. Carlyle, "Cognitive Complexity and Appraisal Effectiveness: Back to the Drawing Board?" Journal of Applied Psychology 67 (1982): pg. 151-60.

rater's schema specific to the situation affecting rating effectiveness.[51] This potential importance of a situation-specific schema provides some hope for the basic and appealing notion of a cognitive compatibility theory.

This concept of rater format complexity and the need for a clear definition of it does present a problem in performance appraisal research. The discussions, reviews, and empirical investigations cited, formed a basis of "format complexity desirability" as a criteria for use in the study being reported. Further, the usefulness of BARS to generate more effective performance feedback, although they may not produce more error-free or accurate ratings than other scale formats, was established from the literature cited.

Performance ratings and halo error

Substantial research has been conducted on the complex phenomenon of performance rating. Not suprisingly, researchers have devoted considerable effort toward identifying and reducing the systematic and random distortions in the rating process. These attempts have dealt primarily with improving traditional rating errors such as leniency, halo, and central tendency, often by adopting different rating formats or through additional rater training programs. However, these time consuming and therefore expen-

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[51]Ibid., pg. 159.

sive efforts are of questionable impact. For example, Borman, Dunnette, and others, suggest that the actual rating scales used account for relatively little error variance in performance ratings.[52] Nonetheless, this large research effort is justified because the vulnerability of performance ratings to rating errors detracts from their ability to satisfy the organizational purposes (e.g., administrative decisions, and employee development) that these performance ratings serve.[53]

Halo effect. Of the various rating error possibilities, the most pervasive form, at least in terms of the amount of directed research, is halo effect. Halo error, or the tendency for scores on presumably independent job dimensions to be significantly intercorrelated, has been seen as a serious threat to the usefulness of performance ratings.[54] Due to the halo effect, individuals are rated as consistently good or consistently poor performers, regardless of their variable strengths and weaknesses.

Approaches to control halo error. Efforts to

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[52]W. C. Borman and M. D. Dunnette, "Behavior-Based Versus Trait-Oriented Performance Ratings: An Empirical Study," Journal of Applied Psychology 60 (1975): 561-65.

[53]Peter W. Hom, Angelo S. DeNisi, Angelo J. Kinicki, and Brendan D. Bannister, "Effectiveness of Performance Feedback From Behaviorally Anchored Rating Scales," Journal of Applied Psychology 67 (1982): 568-76.

[54]W. C. Borman, "Effects of Instructions to Avoid Halo Error on Reliability and Validity of Performance Ratings," Journal of Applied Psychology 60 (1975): 556-60; F. J. Landy and J. L. Farr, "Performance Rating," Psychological Bulletin 87 (1980): 72-107.

control halo error (and other rating errors) fall into two groups--the attempts to reduce halo through nonstatistical means, and the attempts to develop statistical controls for halo effects. The first group of nonstatistical controls is perhaps best portrayed through the independent behavioral anchoring technique described by Smith and Kendal.[55] The use of statistical controls is widely found in the literature. The most popular statistical approach to halo control has been the use of partial correlation techniques.[56] Landy, Barnes-Farrell, Vance and Steele have categorized the typical statistical approaches to control rating error as the following:

1. Increasing the number of judgements made about a particular ratee (either by increasing observations or increasing judges) and aggregating those judgements to improve consistency

2. Developing appropriate normaltive populations for raw scores transformation (e.g., standardize score within location, job title, or experience stratum) and,

3. Using partial correlation techniques to elimi-

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[55]P. C. Smith and L. M. Kendall, "Retranslation of Expectations: An Approach to the Construction of Unambiguous Anchors for Rating Scales," Journal of Applied Psychology 47 (1963): 149-55.

[56]Robert J. Harvey, "The Future of Partial Correlation as a Means to Reduce Halo in Performance Ratings," Journal of Applied Psychology 67 (1982): 171-76.

nate the influence of potentially distorting influences.[57] R. B. Cattell offers a thorough explanation of the partial correlation technique, the third approach above that holds the greatest promise in terms of cost and feasibility.[58]

The partial correlation approach. In essence, the partialing approach asserts that it is possible to remove the halo component from the dimension ratings by statistically eliminating the variance in common between the dimension and overall ratings. The work of Myers and Holzbach suggest the value of this technique to improve certain characteristics of performance ratings.[59] In a job analysis project, J. H. Myers found a high degree of halo in ratings of the gathered job factors.[60] By partialing out the effect of job level on the ratings, he substantially reduced the intercorrelations among the job factors. In a more recent investigation, R. L. Holzbach examined rater bias in performance appraisal situations produced by supervisors, peers and ratees or self-raters. Holzbach regressed an overall

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[57]Frank J. Landy, Robert J. Vance, Janet L. Barnes-Farrell, and James W. Steele, "Statistical Control of Halo Error in Performance Ratings," Journal of Applied Psychology 65 (1980): 501-6.

[58]R. B. Cattell, Handbook of Multivariate Experimental Psychology (Chicago: Rand-McNally, 1966).

[59]J. H. Myers, "Removing Halo From Job Evaluation Factor Structure," Journal of Applied Psychology 49 (1965): 217-221; R. L. Holzbach, "Rater Bias in Performance Ratings: Superior, Self-, and Peer Ratings," Journal of Applied Psychology 63 (1978): 579-88.

[60]J. H. Myers, "Removing Halo From Job Evaluation Factor Structure," Journal of Applied Psychology. 49 (1965): 217-21.

effectiveness measure on six specific performance items obtained, and calculated residual performance ratings. This, in effect, partialed out the influence of overall effectiveness on individual performance measures. Thus, Holzbach demonstrated that halo was substantially reduced in supervisory ratings when overall effectiveness dimensions were held constant. This is an important contribution since most performance appraisals are conducted by supervisors. However, this technique is not without numerous critics.[61] The arguments against statistical controls for halo are best described by Robert J. Harvey as follows:

> In summary, I have criticized the practice of statistically controlling for halo in performance ratings on two main points. First, correct use of the technique is seen to depend on the validity of specific causal assumptions that have yet to be tested. Second, methodological problems with past studies using the partialing approach could call into question the previous reports of the empirical effectiveness of partialing (regardless of the logical problems associated with the technique).[62]

It is difficult, in the absence of a good description of "true" performance, to determine what is the true score or error score when using the partialing technique.

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[61]Kevin R. Murphy, "Difficulties in the Statistical Control of Halo," Journal of Applied Psychology 67 (1982): 161-64; Charles L. Hulin, "Some Reflections on General Performance Dimensions and Halo Rating Error," Journal of Applied Psychology 67 (1982): 165-70; Robert J. Harvey, "The Future of Partial Correlation as a Means to Reduce Halo in Performance Ratings," Journal of Applied Psychology 67 (1982): 171-76.

[62]Robert J. Harvey, "The Future of Partial Correlation as a Means to Reduce Halo in Performance Ratings," Journal of Applied Psychology 67 (1982): 171-76.

Alternative processing models. Derived from the cognitive categorization theories beginning with Borman's traditional approach, Feldman and Lord have proposed an alternate process model of performance appraisal.[63] Previously, Borman stated that performance evaluations should follow a three-step process:

> 1. Observing work-related behaviors
> 2. Evaluating each of these behaviors in terms of the effectiveness it represents, and
> 3. Weighing these evaluations to arrive at a single rating on a performance dimension[64]

According to the alternative process model, halo is the result of a heuristic process in which information is stored. This information forms the basis of a prototypical category system. Here, the category base should contain a set of generally representative behavior characteristics. In a normal performance appraisal environment, where ratings are conducted on a repetitive schedule, the alternative process model suggests that the already existing prototype serves as the basis for subsequent behavioral ratings rather than the originally observed behaviors. This infers that halo is produced by a very common means of simplifying information processing. An investigation by Nathan and Lord concludes that the alternative causal models Harvey dis-

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[63]Barry R. Nathan and Robert G. Lord, "Cognitive Categorization and Dimensional Schemata: A Process Approach to the Study of Halo in Performance Ratings," Journal of Applied Psychology 68 (1983): 102-14.

[64]W. C. Borman, "Exploring Upper Limits of Reliability and Validity in Job Performance Ratings," Journal of Applied Psychology 63 (1978): pg. 141.

cussed form direct analogs between the information processing--traditional models, and indicates that the traditional model was appropriate for describing the rating process.[65]

The various research described above served a valuable role in the development and assessment of the instrument and statistical tools used in this research endeavor. Discussion of the problems and possible solutions to the presence of halo were incorporated in the analysis portion of this effort.

Summary

The extent of research directed toward the physically impaired employee has been of questionable value. Accordingly, a more complete and competent approach to the performance measurement of a group of physically impaired workers and a group of non-impaired co-workers should be undertaken. The results from such an updated approach could substantiate those questionable findings that were previously cited--that there exists no difference between the performance levels of the two groups.

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[65]Barry R. Nathan and Robert G. Lord, "Cognitive Categorization and Dimensional Schemata: A Process Approach to the Study of Halo in Performance Ratings," Journal of Applied Psychology 68 (1983): 102-14.

CHAPTER III

DATA COLLECTION

The primary data used in this study were gathered through research questionnaires. These questionnaires were directed toward two groups: (1) the graduates of the ARPDP, and (2) the immediate supervisor of those graduates.

The Environment

The ARPDP

The Association of Rehabilitation Programs in Data Processing (ARPDP) was formed in 1978 from the original IBM Computer Programmer Training for the Severely Disabled project, initiated in 1972. The objective of the IBM project, and the Association, is to establish, within responsible rehabilitation agencies, self-sustaining programs for training and placing severely physically handicapped individuals as computer programmers. The program strives to develop graduates with entry level programming skills in a language responsive to the needs of the local business sector. The typical length of the training program is 9 or 10 months, and conventional group lecture/lab classes are conducted 5 days a week for approximately 2.5 hours each morning with an additional 2.5-3.0 hours set aside each afternoon for independent lab work. Examples of the structured course modules

are:

1. Data processing and programming fundamentals
2. Detailed language instruction
3. Prescriptive sessions designed to fit each student to his/her job

Additionally, the training program includes an active advisory committee composed of representatives from the rehabilitation, handicapped, education, and business communities. The business members come primarily from the data processing, business operations, personnel, and training departments of the participating firms. They are able to define with authority the basic skills that a graduate should possess to be employable as an entry level programmer, and to assist in developing a course that would produce such a graduate. In addition, the business group participation allows the student to observe first-hand the environment in which a programmer must function, and the group assumes job placement responsibilities for the class. Class size is small to ensure adequate training experience. One-hundred and seventy nine (179) employed graduates were eligible for inclusion in this study.

The employers

The firms which currently employ graduates of one of the ARPDP's programs are varied in size, industry type and location. Among the list are large private firms including IBM, Standard Oil of California, Bank of America, and Firemans Fund, along with various federal, state and local

agencies. Several universities including the University of Missouri--Columbia, University of Cincinnati and the University of California--Berkeley also employ ARPDP graduates. All firms engaged in information processing are potential program participants.

The Design of the Questionnaire

The questionnaire, which appears in appendix 2, is an adaptation of Michael Beer's "performance dimension questionnaire."[66] This instrument identifies forty-three items that deal with individual employee performance. Beer's description of the questionnaire follows:

> Each behavioral statement is rated on a six point "Likert Scale" by the supervisor indicating the extent to which the supervisor agrees that the statement reflects the subordinates [sic] behavior. There is a provision for not rating due to "insufficient information" or an estimate by the supervisor that the item is "not relevant" given the person's job.[67]

Development of questions

The questionnaire used in this research effort is an adaptation of the behavioral ratings system developed by Michael Beer for the Corning Glass Works. The Corning Glass Works behavioral rating system is, in turn, similar to the salesman's rating system developed by Dunnette and Kirchner

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[66]Michael Beer, et al. "A Performance Management System: Research, Design, Introduction and Evaluation." Personnel Psychology 31 (1978).

[67]Ibid., pg. 509.

in 1957.[68] Through a process involving managers from different functions, levels and divisions within Corning, numerous "critical incidents" of the observed performance of subordinates were collected.[69] This effort returned approximately three hundred behavioral statements. These were then translated into a more general form and further reduced to eliminate duplication. The remaining two hundred questions were placed in a "performance description questionnaire" and sent to a representative cross-sectional sample of three hundred Corning Glass Works managers.[70] After employing factor analysis techniques to aid in the data reduction, seventy-six behavioral statements remained. Of these seventy-six statements, forty-three items over eleven dimensions of performance dealt with the performance of individual salaried employees and the additional thirty-three items covered eight dimensions of the performance of supervisory others.[71] The questionnaire used in this particular study includes a series of queries to indicate the size and characteristics of the data processing installation. The layout of the questionnaire follows the guidelines specified by Don Dillman's "total design method" that

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[68]Dunnette, M. D. and Kirchner, W. "Identifying the Critical Factors in Successful Salesmanship." Personnel 34 (1957): pg. 54-9.

[69]Michael Beer et al., "A Performance Management System: Research, Design, Introduction and Evaluation." Personnel Psychology 31 (1978): pg. 509.

[70]Ibid.

[71]Ibid., pg. 512.

is described in greater detail later in this chapter.[72] The use of boldface type to delineate the various performance dimensions and the incorporation of check-off blocks promote survey participation and ease of completion.

The participants were assured of complete confidentiality. Of the ARPDP graduates that were included in the study, 100 percent requested a summary of the results. Fifty-five (55) percent of the supervisors that responded to the survey indicated that they desired a summary of the results.

Numerical value assignment

Assignment of point values to each behavioral variable response followed the Likert scale. Subjectively, the values one through seven were chosen to represent the responses of (1) insufficient information, (2) strongly agree, (3) somewhat agree, (4) undecided, (5) somewhat disagree, (6) strongly disagree, and (7) not relevant.

Implementation of the Survey

The total design method

In order to better prepare for the development of an adequate survey instrument, a search of the available literature dealing with mail surveys was undertaken. The result was generally a discouraging story of poor or untreated responses, poor response rates and unacceptable

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[72]Don A. Dillman, Mail and Telephone Surveys: The Total Design Method (New York: John Wiley and Sons, 1978).

time constraints. Social scientists have viewed them as having little worth.[73] However, one work described in detail a methodology for conducting mail and telephone surveys using questionnaires of a length and complexity appropriate for social science research. Don Dillman expresses how the "total design method" solves, in part, the historical problems of mail survey response quantity and quality.

> . . . the "total design method" . . . is . . . the identification of each aspect of the survey process (even the minute ones) that may affect response quantity or quality and shaping them in a way that will encourage good response. These efforts are guided by a view about why people do and do not respond to interviews and questionnaires, and a concern that the weakest link in surveying is often the researcher's inability to mount and carry through a precisely ordered and timed implementation process so necessary for maximizing response. Thus the total design method (TDM) . . . rests on both a theory of response behavior and an administrative plan to direct its implementation.[74]

As an attempt to improve on past mail survey outcomes and increase the worth of this study, the TDM was adopted.

Questioning the ARPDP graduates

A letter explaining the nature of this research effort and asking for the name and address of the graduate's

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[73]M. Parten, Surveys, Polls and Samples (New York: Harper and Row, 1950); Claire Sellitz et al., Research Methods in Social Relations (Chicago: Holt, Rhinehart and Winston, 1959); Fred N. Kerlinger, Foundations of Behavioral Research (New York: Holt, Rhinehart, and Winston, 1965).

[74]Don A. Dillman, Mail and Telephone Surveys: The Total Design Method (New York: John Wiley and Sons, 1978), pg. 2.

supervisor was mailed to each of the 179 employed graduates of the ARPDP. A cover letter, questionnaire enclosure, and follow-up documents as suggested by Dillman's TDM are located in appendix 1. This approach allowed each graduate to decide if inclusion in this study posed a threat to his/her current employment, and gave them the opportunity to decline if this was the case. Also, the cover letter encouraged the ARPDP graduates to telephone the researcher to discuss the project in greater detail. The telephone conversations that resulted proved enlightening to the researcher and served as valuable input to questions worthy of possible future research. Certain of these areas are discussed in greater detail in chapter 5. Responses are shown in table 2. Although one hundred and one of the original one hundred and seventy-nine ARPDP graduates responded to the questionnaire, only seventy-three of the responses qualified for inclusion in the remainder of the study. Twenty-eight respondents were excluded from further participation due to (1) their self-reported unemployed status, or (2) their choice to withhold the name and address of their immediate supervisor. The remaining seventy-three employed graduates of ARPDP training programs who returned questionnaires formed the mailing list for the portion of the study directed toward supervisors.

TABLE 2

ARPDP GRADUATES' RATE-OF-RETURN

Mailing	Number of Responses	Percentage of Total (179)	Number of Responses Qualifying for the Study	Percentage of Total (179)
Initial*	89	49.72	63	35.20
Second	12	6.70	10	5.59
Total. .	101	56.42	73	40.79

*Included in the initial mailing values are respondents that replied after having received a follow-up postcard sent two weeks after the initial mailing.

Questioning the supervisor

A cover letter explaining the purpose of the study and asking for participation was mailed to all of the supervisors obtained from questioning the graduates. Again, the TDM was utilized and the letters and follow-up material are located in appendix 1.

Of the seventy-three superviosrs contacted, fifty responded by completing two questionnaires: (1) one regarding the physically impaired worker and (2) one regarding the non-impaired co-worker. Additionally, there were several questions on each questionnaire of special interest to this project. A summary of responses is shown in table 3.

TABLE 3

SUPERVISOR QUESTIONNAIRE RATE-OF-RETURN

Mailing	Number of Responses	Percentage of Total (73)	Number of Valid Responses	Percentage of Total (73)
First*	25	34.25	25	34.25
Second	31	42.47	25	34.25
Total. .	56	76.72	50	68.50

*A follow-up postcard, reminding the supervisors of the study, was sent two weeks after the first mailing. The responses from both the first mailing and the follow-up postcard are shown in the single category "First". The postcard and cover-letters accompanying the questionnaire can be found in appendix 1.

Summary of Respondents

This section contains charts which provide a view of the organizations participating in the survey. These bar charts (figures 2 through 9) were developed from information requested in section XII (Q-44 through Q-52) of the questionnaire in appendix 2.

Figure 2 illustrates that 20 of the 50 companies (40 percent) employed between 10,000 and 99,999 workers worldwide. Figure 3 details the fact that most (38 percent) of the data processing sections contained no more than 50 employees. Figure 4 again addresses the number of employees. This time, the interest was on the size of the facility at which the impaired and non-impaired workers operated. The majority (36 percent) performed their duties at a facil-

ity which employed between 1 and 100 individuals, while only 2 percent functioned in an environment consisting of greater than 5001 employees. Figure 5 indicates the reported annual data processing expenditures on equipment. Figure 6 describes the type of computer system used, and the dominance of IBM (52 percent). Figure 7 describes the primary work areas that were reported. Figures 8 and 9 provide values concerning whether or not the supervisor knew that the impaired worker was a graduate of one the ARPDP training facilities and information regarding the classification of this worker's impairment.

This information was gathered only to provide additional information regarding the organizations that have employed graduates of the ARPDP. Some limited discussion of the usefullness of this information to the ARPDP can be found in chapter 5.

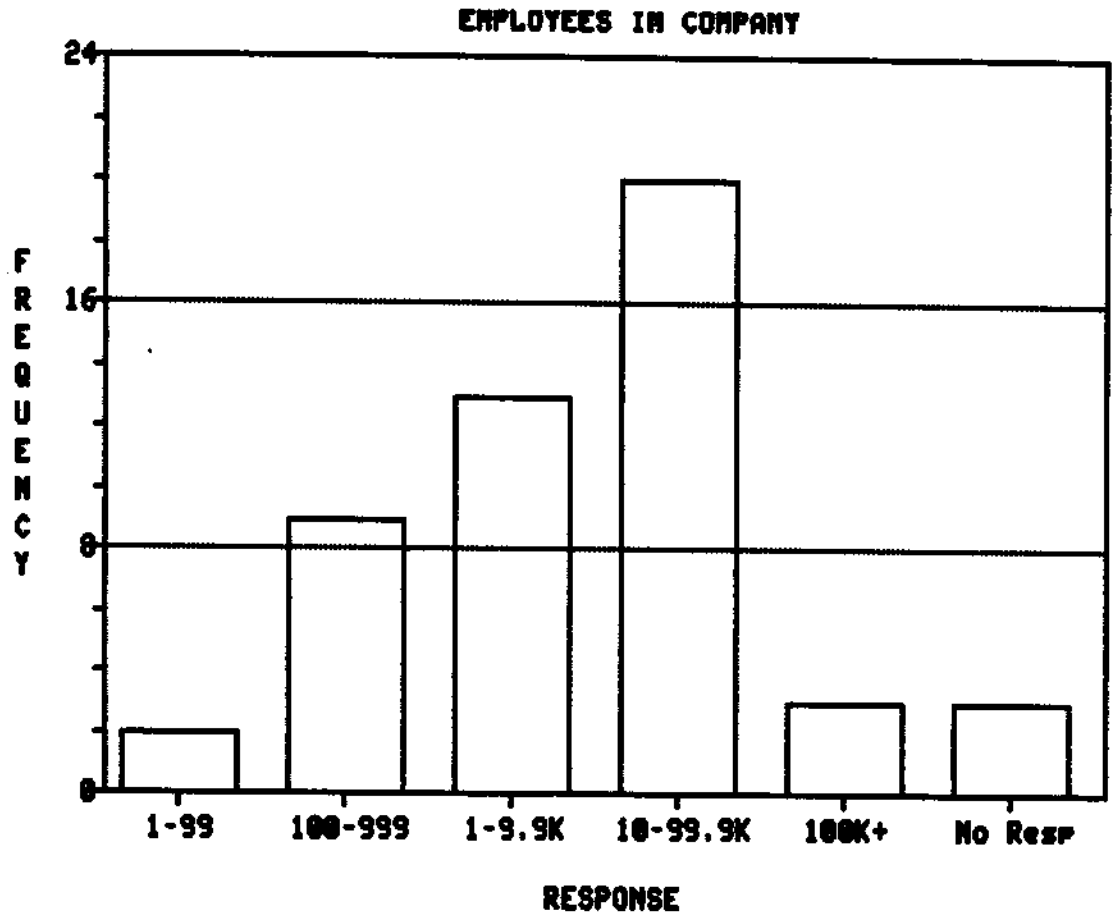

Fig 2. Employees in company (K equals thousands)

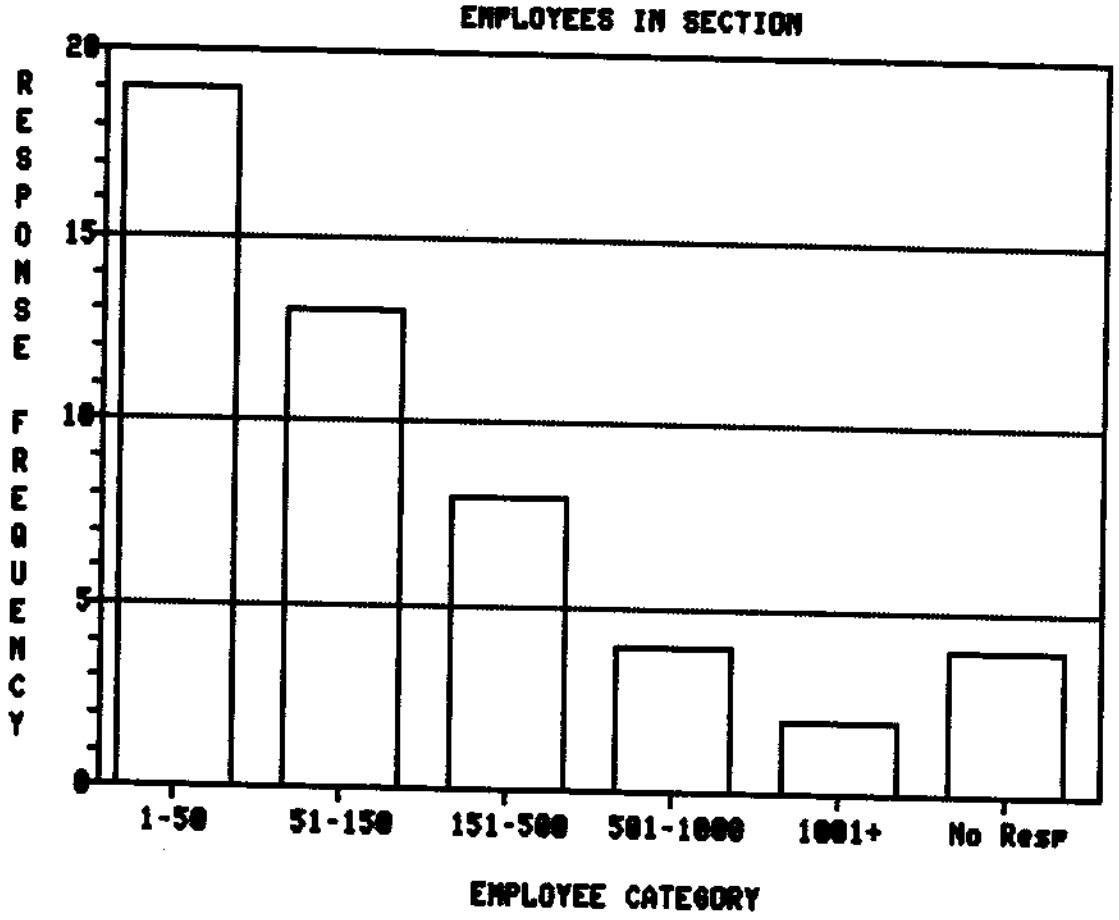

Fig 3. Employees in section

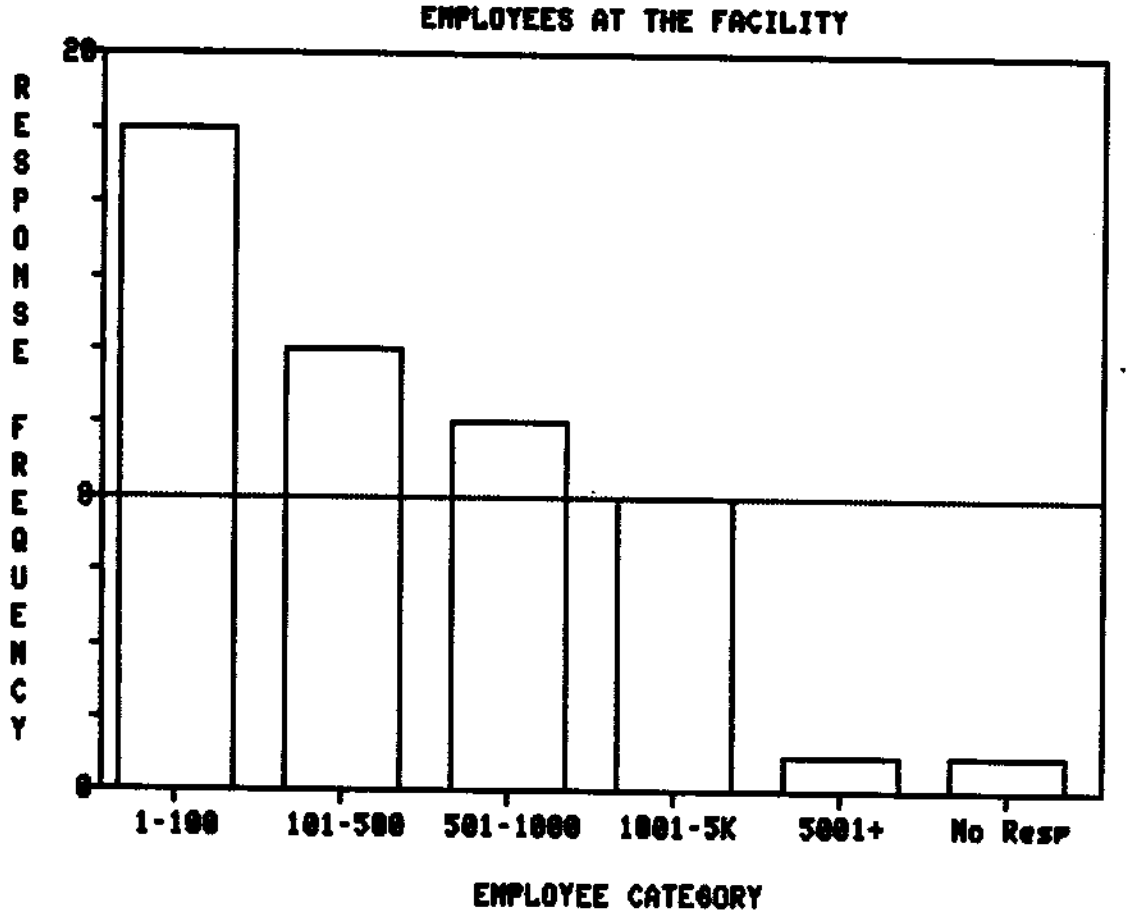

Fig 4. Employees at the facility (K equals thousands)

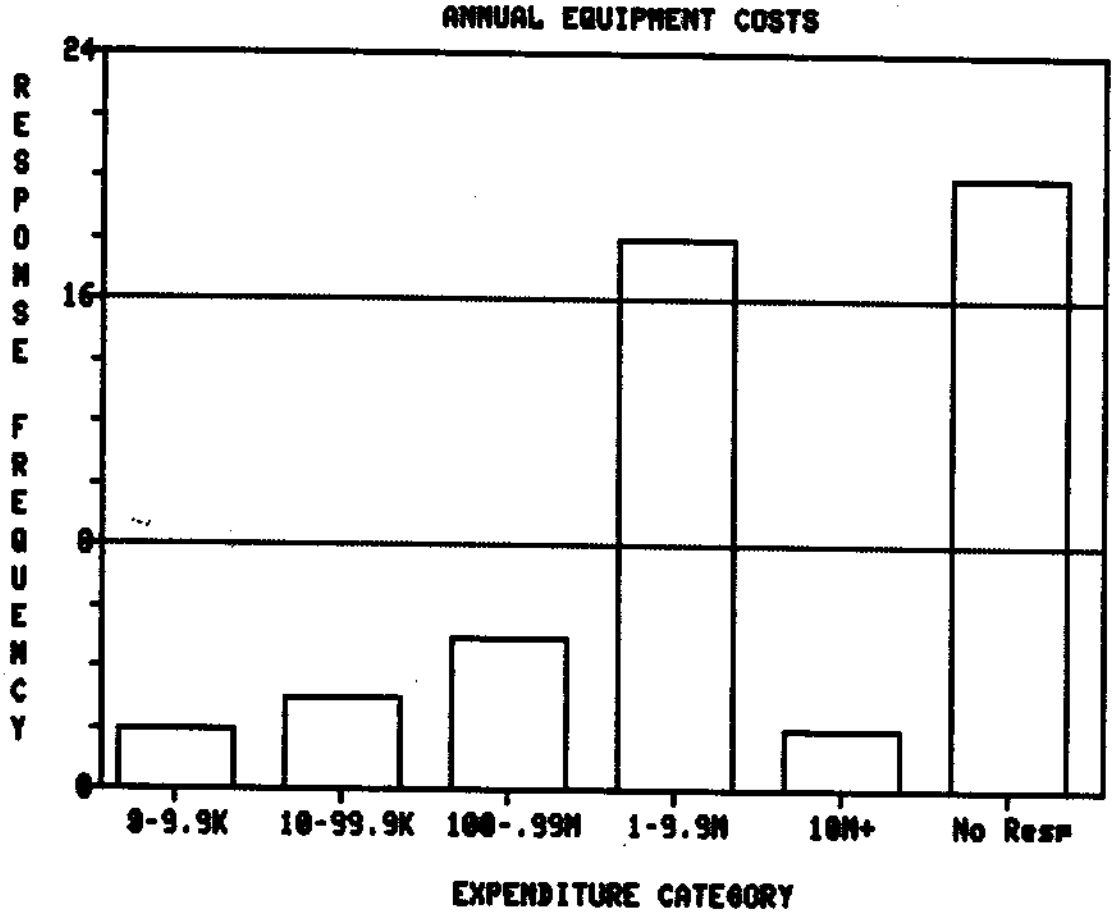

Fig 5. Annual data processing equipment expenses (K equals thousands, M equals millions)

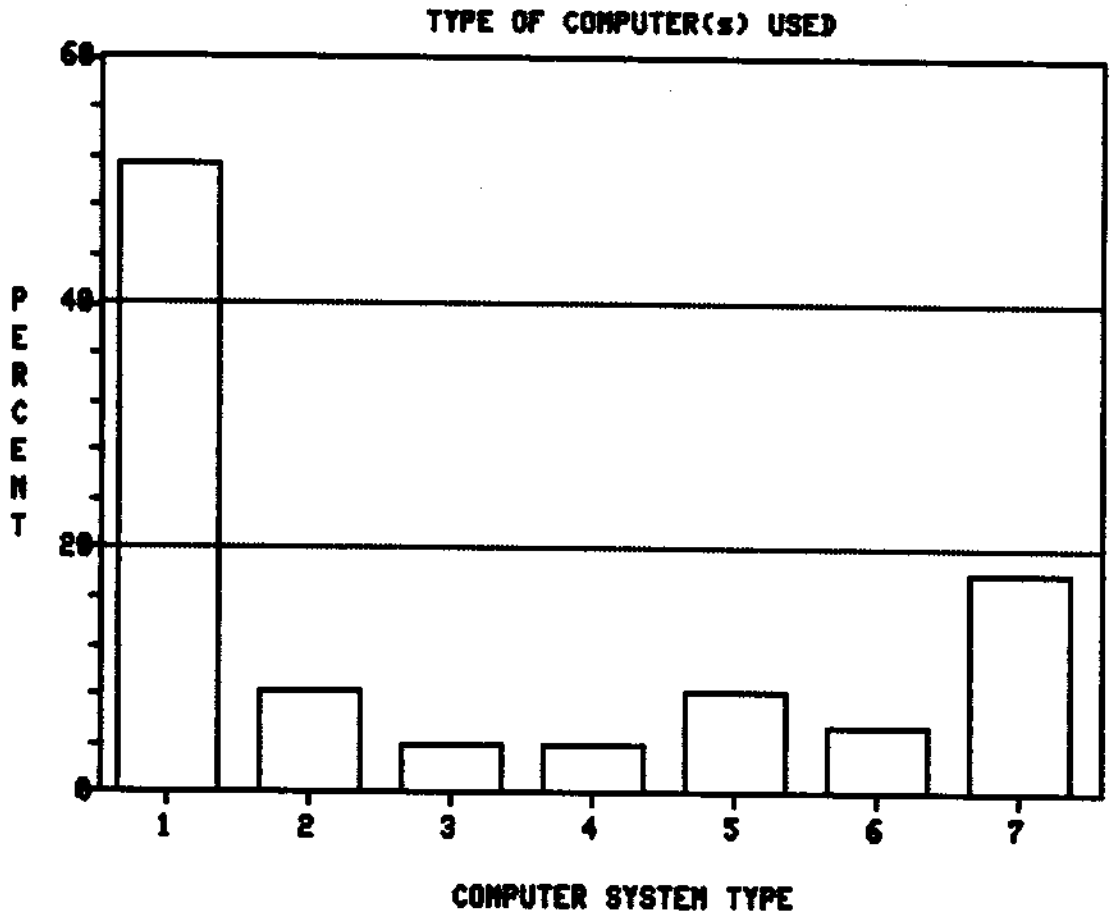

Fig 6. Type of computer(s) used. The types of computer systems reported are as folows: (1) IBM, (2) Honeywell, (3) Amdahl, (4) Data General, (5) Digital Equipment Corporation, (6) Hewlett-Packard, and (7) numerous desk-top microcomputer systems from a varied group of manfacturers.

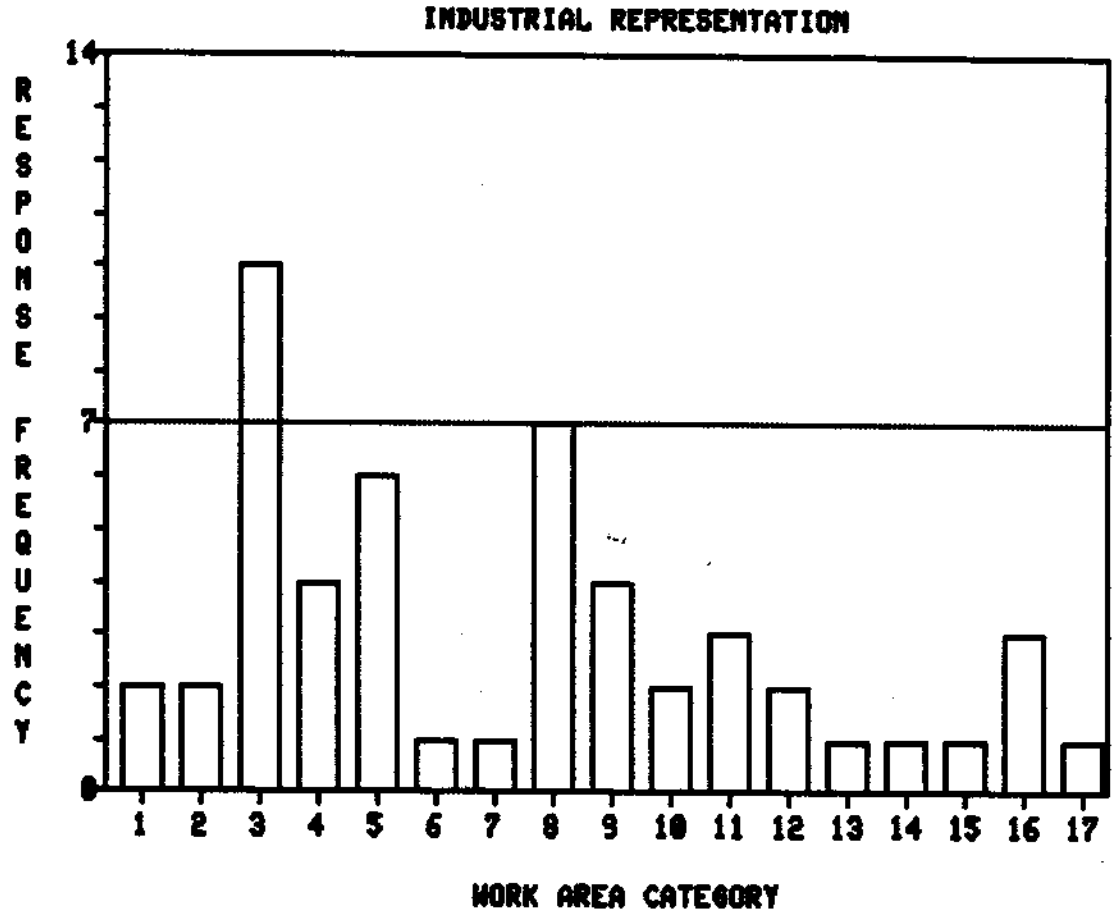

Fig 7. Primary work area

The work area categories are as follows: (1) direct mail, (2) transportation services/distribution, (3) education, (4) banking, (5) manufacturing, (6) defense, (7) aeronautics/space, (8) insurance, (9) accounting--MIS, (10) data processing--services, (11) public utility, (12) engineering, (13) consulting, (14) marketing, (15) communications, (16) health care, and (17) petroleum.

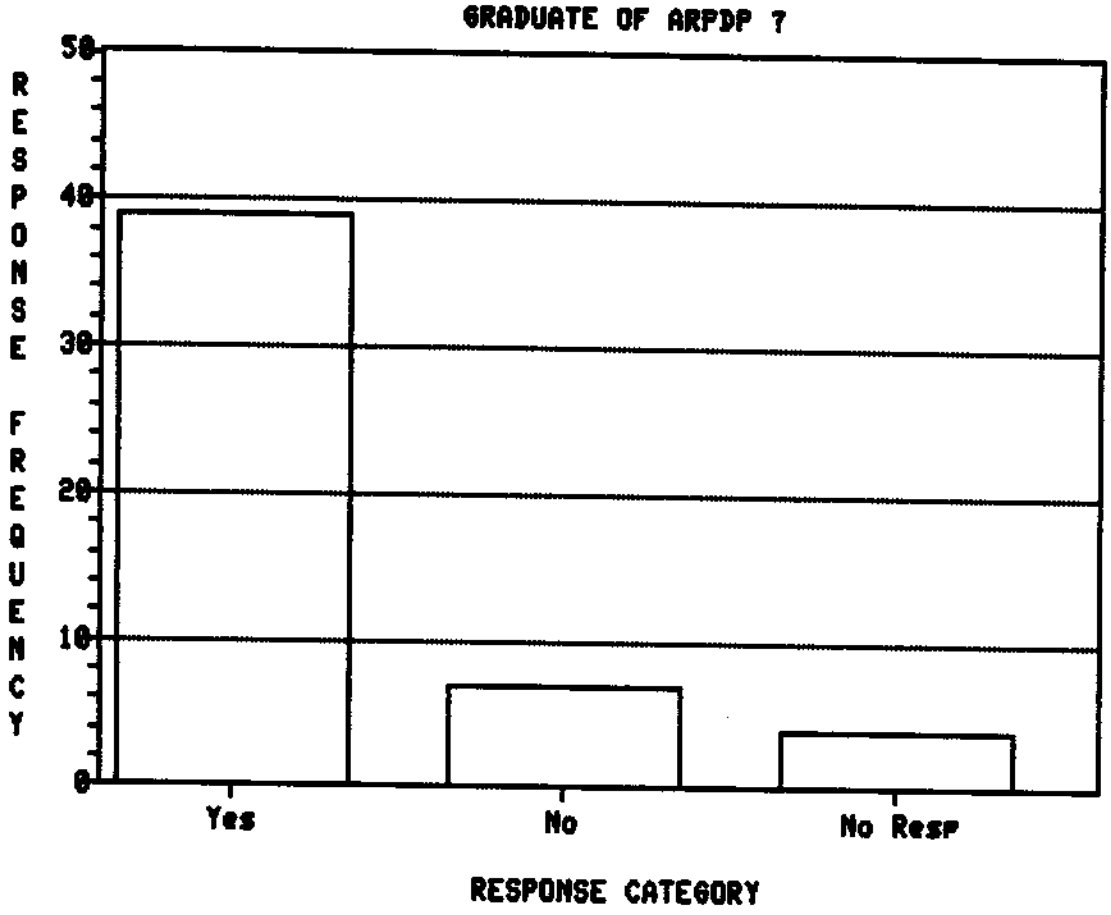

Fig 8. Graduate of ARPDP?

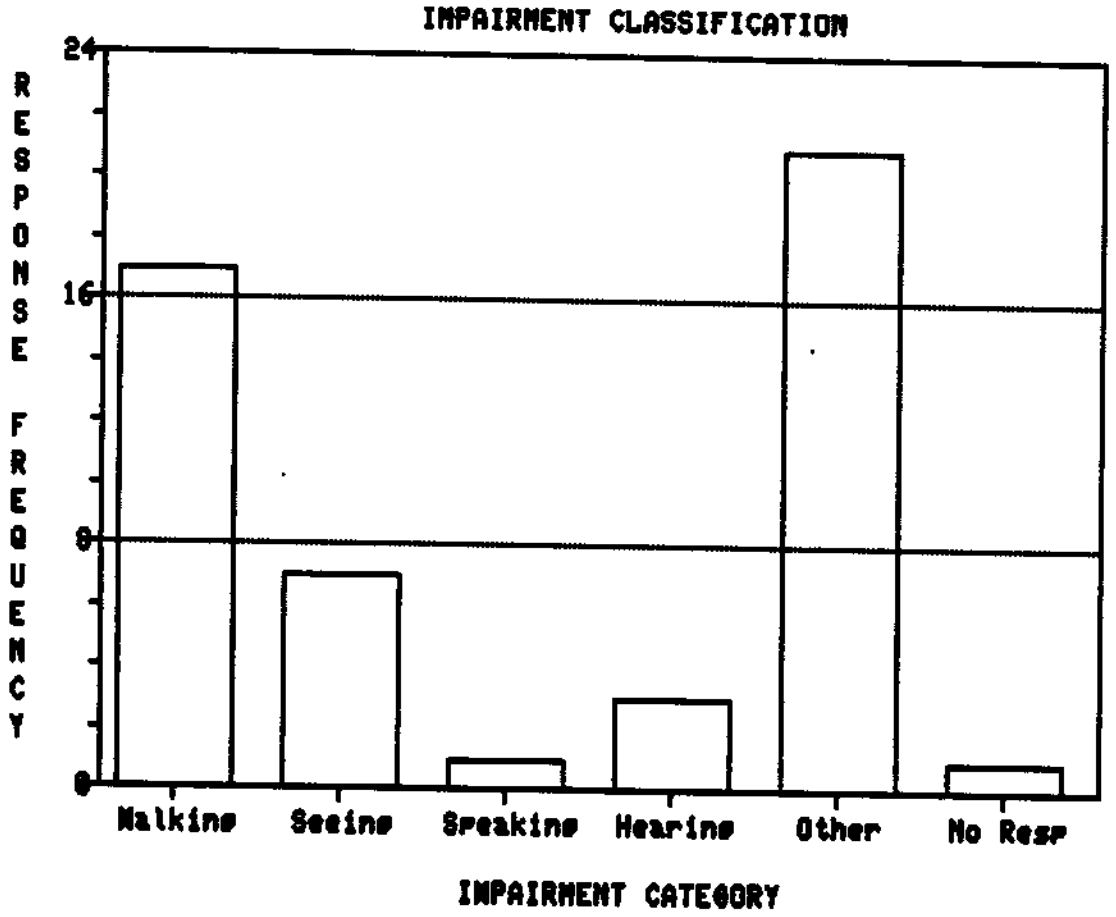

Fig 9. Impairment classification

* This category includes responses indicating the presence of multiple impairments (e.g. seeing and speaking, or walking and hearing).

CHAPTER IV

SURVEY ANALYSIS

The data obtained from questionnaires were subjected to parametric and non-parametric tests in the analysis phase of this study. Measurement tools used to investigate possible differences between the two groups of workers included discriminant and factor analytic techniques along with application of the sign test. The tools used are briefly described and followed by the results of each phase of the study. The discussion is best divided into three areas: (1) data reduction through factor analysis, (2) application of the sign test, and (3) discriminant analysis. This chapter concludes with a short summary of the results.

Data Reduction Through Factor Analysis

After the performance description questionnaires containing the behavioral ratings were returned, the data were subjected to principal component factor analysis (PCA). Factor analysis is one of several techniques used in reduced space analysis. For instance, if each original variable denotes a dimension of the data space, then reduced space techniques, as the name suggests, attempt to find a smaller number of dimensions that retain most of the information in

the original space.[75] Although factor analysis has become a generic term for many procedures used in effecting desired dimensional reduction, the principal components model is one of the most popular. The component model, sometimes referred to as the principal component model, seeks linear composites of the original variables that display certain desirable properties, namely, scores that exhibit maximal variance, subject to being uncorrelated with previously computed composites.[76] Since the objective at the early point in this research process was to summarize most of the original information (variance) in a minimum number of factors, the principal component model is the appropriate statistical tool. Factor analysis--in particular, the principal components method--proceeds in a sequence of steps:

1. Rotation of the initial configuration of points (objects) to a new orientation, of the same dimensionality, that exhibits the characteristic of mutually orthogonal dimensions with sequentially maximal variance. That is, the first dimension displays the largest variance of point projections. The second dimension displays the next largest variance, subject to being orthogonal to the first, and so on.

2. Reducing the dimensionality of this transformed space, usually by discarding those higher dimensions that exhibit the smallest variance of point projections.

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[75]Aaker, D. A. (ed), Multivariate Analysis in Marketing: Theory and Application (Belmont, Ca: Wadsworth, 1971).

[76]Alpert, M. I. and Peterson, R. A., "On the Interpretation of Canonical Analysis." Journal of Marketing Research 9 (1972): pg. 187-92.

3. Finding still a new orientation of the reduced space that makes the retained dimensions more interpretable from a content point of view.

4. Substantive interpretation of the reoriented dimensions in terms of the variables that show high association with each dimension.[77]

The purpose for the application of this technique is to identify appropriate variables for use in a subsequent discriminant analysis. The variables chosen for further analysis are to be those items with the highest loading on the "general" or first factor as a result of the application of the P4M factor analysis program included in the P-series of the Biomedical Computer Programs (BMDP).[78] Again, these screened items formed the basis for a discriminant analysis and eventual testing of the hypothesis.

Data

One-hundred cases (fifty matched pairs) were available for factor analysis. Limits and missing values were checked before analysis was started. This process of eliminating cases containing missing data was accomplished to prevent any false interpretation. Since, in an initial factor analysis run, the P4M factor analysis program reported that the correlation matrix was singular[79] (that is, one

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[77]Green, Paul E., Analyzing Multivariate Data. (Hinsdale: The Dryden Press, 1978), pg. 343.

[78]Dixon, W. J., Biomedical Computer Programs P-Series (Los Angeles: University of California Press, 1979).

[79]James W. Frane and Mary Ann Hill, "Annotated Computer Output for Factor Analysis: A Supplement to the Writeup For Computer Program BMDP4M." (Los Angeles: Univer-

variable is a linear combination of the others), the analysis was performed without the inclusion of the following variables: (1) priority setting--Q-15 and Q-17, (2) organizational perspective--Q-23, (3) thoroughness and accuracy--Q-31, (4) work accomplishment--Q-37, and (5) decisiveness--Q-43. The presence of a singular correlation matrix is reflected in the value of the squared multiple correlation (SMC) of each variable. When the SMC of a variable with all other variables is equal to one, that variable is a linear combination of the others. One would not want to include in the analysis a variable which is a linear combination of those variables already involved, because it has no unique information to contribute. Of the remaining thirty-seven variables, thirty-eight responses were qualified for further factor analysis. The use of a minimum value of two and a maximum of six insured that only behavioral ratings as discussed in chapter 3 were included in the analysis. Due to the application of these data value limits, non-behavioral supervisory responses of (1) insufficient information, and (7) not relevant were not included. Additional statistics for these cases, including the SMC's from the singular correlation matrix produced in the inital factor analysis investigation, are located later in this chapter and in appendix 3.

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sity of California Press, Health Sciences Computing Facility, 1974): pg. 4.

Factor analysis applications

Two applications of the factor analytic technique were employed in this study. The first, unrotated principal components analysis, was undertaken to investigate an expected high loading of most or all variables on the first factor. The second, rotated principal components analysis, served as a data reduction step for the upcoming discriminant analysis.

Unrotated factor application. A principal components factor analysis was applied to all variables with the exception of variables 15, 17, 23, 31, 37, and 43. Tables containing (1) communalities obtained from nine factors after one iteration and (2) the squared multiple correlation (SMC) of each variable with all others are discussed latter in this chapter.

Results of this phase of the study confirmed the previously expected occurrence of most or all of the variables being highly loaded on the first or general factor. It is also apparent from the large SMC values that the variables included in this study are all highly associated. This is not necessarily unfortunate, as one of the practical assumptions for factor analysis is that every variable is somewhat highly correlated with some other variable or variables.

Number of factors to retain. Principal components produce one component for each variable included in the analysis. Hence, using 'n' components will reproduce the

original 'n' variables. Since this is not a very simplified result, some method of retaining a smaller number of factors must be incorporated. The problem of how many factors exist in the data is settled in the following variety of ways:

> Prior theory. By far the best way to determine how many factors exist in the data is to employ prior theory (e.g., a theory that people think about colors on three dimensions).
>
> Available space. Sometimes the available space on a questionnaire or the limitations of a computer program or analytical procedure will dictate the maximum number of variables to retain.
>
> Examining the results. When prior theory is unavailable (or questionable) as a guide, a researcher must resort to examining the data for a clue as to how many factors exist. One approach is to use trial and error, finding the best solution for two factors, three factors, and so forth, and then choosing the solution which is most useful/felicitous/pleasing. Aside from the potential for researcher bias influencing the choice adversely, this method is not very efficient. Hence, a more mechanical approach is often desired.[80]

Examining the eigenvalues (or characteristic values) of the principal components solution is the most common approach for determining the number of factors to be retained. Remembering that a principal components solution produces 'n' components for 'n' variables, it happens that these variables indicate what percent of the total variance is accounted for by each of the factors. When the correlation matrix is used as the basis for factoring, the percent of the variance accounted for by the 'j'th component becomes

$$\frac{\text{Eigenvalue}_j}{\text{Number of variables}}$$

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[80]Donald R. Lehman, Market Research and Analysis (Homewood: Richard D. Irwin, Inc., 1979), pg. 546.

Donald Lehmann[81] explains that this formula allows the percent of total variance accounted for to be used as a criterion for determining the number of factors in several ways:

1. By requiring inclusion of enough factors to reach a certain level of total variance explained.
2. By requiring any factor to explain at least the amount of variance which a truly independent variable would explain. If all the original variables were independent, then each component (which would equal one variable) would explain 1/n percent of the total variance and have an eigenvalue equal to 1. This criterion is often known as the eigenvalue-greater-than-one rule and tends to produce good (interpretable) results.[82]
3. By requiring each subsequent factor to explain a substantial and/or significant amount of the residual variance. This sequential testing approach can be done in many ways . . .

The BMDP P-series computer programs adhere to the second criteria mentioned above as illustrated in table 4. From the application of the second criteria, nine factors were obtained in the principal components analysis. The first unrotated factor sometimes can be interpreted as a general factor. Here the relatively large amount of the total variance explained by the first factor (35.5 percent) confirms the presence of a general "halo" factor described by

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[81]Ibid., pg. 547

[82]An interesting empirical phenomenon which occurs in survey research data is that one third of the components will have eigenvalues greater than one, and this one third of the components will account for two thirds of the variance in the original variables. For example, if there are 39 original variables, one would typically get about 13 eigenvalues greater than one. This "rule" also provides a tip-off to the amount of collinearity in the data since one third of the components accounting for 85 percent of the variance means unusually high collinearity, and one third accounting for 50 percent indicates atypically low intercorrelations among the original variables.

Michael Beer, et, al.[83] Appendix 3 contains both the sorted and unsorted unrotated factor loading for the principal components analysis. The phenomenon of high loadings on the first factor led to the eventual discriminant analysis of all variables included in this initial unrotated factor study. This discriminant portion of the study is discussed later in this chapter.

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[83]Michael Beer et al., "A Performance Management System: Research, Design, Introduction and Evaluation." Personnel Psychology 31 (1978): pg. 510.

TABLE 4

VARIANCE EXPLAINED BY EACH FACTOR
WITH NO ROTATION

Factor	Variance Explained (Eigenvalue)	Cumulative Proportion of Total Variance
1.	13.153	0.355
2.	3.362	0.446
3.	3.270	0.535
4.	2.558	0.604
5.	1.814	0.653
6.	1.533	0.694
7.	1.381	0.732
8.	1.321	0.767
9.	1.136	0.798
10.	0.937	0.823
11.	0.913	0.848
12.	0.885	0.872
13.	0.654	0.890
14.	0.559	0.905
15.	0.472	0.918
16.	0.436	0.929
17.	0.404	0.940
18.	0.389	0.951
19.	0.342	0.960
20.	0.305	0.968
21.	0.246	0.975
22.	0.186	0.980
23.	0.171	0.985
24.	0.140	0.988
25.	0.108	0.991
26.	0.078	0.993
27.	0.064	0.995
28.	0.055	0.997
29.	0.036	0.998
30.	0.028	0.998
31.	0.025	0.999
32.	0.014	0.999
33.	0.012	1.000
34.	0.008	1.000
35.	0.002	1.000
36.	0.001	1.000
37.	0.000	1.000

Rotated factor application. Since the reduction of the data into a smaller number of variables for future study

through the application of discriminant techniques was a goal of the factor analysis phase of this study, a rotational methodology was applied to simplify the factor structure. An orthogonal type of rotation (varimax) was requested due to its ability to maximize the variance of a column of the pattern matrix. The simplified interpretation that is obtained from rotating the factors stems from making the loadings for each factor either large or small, and not in-between. Before the selected method of rotation is applied, a correlation matrix containing all variables included in the analysis is computed. Although the diagonal of this matrix contains 1.0 (the correlation of a variable with itself), when this matrix is factored, an adjusted correlation matrix where the diagonal contains a communality estimate is achieved. This estimate is a measure of the variation of an observed variable accounted for by the common factors of the analysis. The communality (sometimes referred to as h^2) in an orthogonal factor model is equivalent to the sum of the squared factor loadings. Table 5 contains the communalities obtained from nine factors after one iteration. Here, the communality of a variable is its squared multiple correlation (covariance) with the factors. For each variable, the communality is the proportion of the variance of that variable that can be explained by nine factors. If fewer factors had been requested, the communalities would have been smaller. For example, the proportion of the variance that can be explained by nine factors for

variable number one is 0.8492 or 84.92 percent. Low communality values suggest that the variable has little to do with the other variables or with the factors delineated in the study.

Table 6 shows the SMC of each variable with all others. The SMC multiplied by 100 measures the percentage of variation that is explained for some one variable or variables included in the analysis. From viewing table 6, it is apparent that the variables included in this study are all highly associated. For instance, the SMC for variable number one (a collaboration variable) is 0.99588. This is interpreted to mean that 99.588 percent of this particular collaboration variable can be predicted from one or more of the remaining thirty-six variables comprising the investigation.

TABLE 5

COMMUNALITIES OBTAINED FROM NINE FACTORS
AFTER ONE ITERATION

	Variables	Communality (h^2)
1.	Offers constructive ideas	0.8492
2.	Provides assistance	0.7595
3.	Goes beyond bare requirements	0.8260
4.	Behavior causes favorable reaction	0.8331
5.	Has confidence of superiors	0.8495
6.	Has confidence of peers	0.7877
7.	Objects to ideas before explained	0.7825
8.	Refuses suggestions or advice	0.7313
9.	Avoids criticism by blaming others	0.6930
10.	Tends to approach things in own way	0.7934
11.	Takes initiative in group meetings	0.7184
12.	Offers constructive ideas to others	0.7215
13.	Attempts to expand knowledge	0.7923
14.	Communicates ideas with conviction	0.8131
15.	Distinguishes problems importance	excluded
16.	Establishes work priorities	0.7462
17.	Takes action based on importance	excluded
18.	Considers alternatives of action	0.8593
19.	Gives poor presentations	0.8110
20.	Dull monotone speech	0.7890
21.	Speaks clearly before groups	0.8433
22.	Prepares incomplete reports	0.8706
23.	Does not limit thinking to self	excluded
24.	Works with people outside department	0.8471
25.	Keeps objectives of firm in mind	0.6145
26.	Fails to communicate across depts.	0.8424
27.	Will attempt new methods	0.8633
28.	Adapts readily to new situations	0.8696
29.	Does not keep current in field	0.8097
30.	Enthusiastic in new work assignments	0.6846
31.	Gives attention to detail	excluded
32.	Is accurate in work	0.7701
33.	Uses scientific approach	0.7514
34.	Is not thorough in approach	0.8877
35.	Makes illogical assumptions	0.7660
36.	Difficulty in meeting deadlines	0.8425
37.	Needs to be "pushed" to finish	excluded
38.	Utilizes time available	0.7966
39.	Will take initiative	0.8558
40.	Hesitates to make decisions	0.7959
41.	Will act on own initiative	0.8087
42.	Works well under pressure	0.8528
43.	Uses good judgment	excluded

TABLE 6

SQUARED MULTIPLE CORRELATIONS (SMC) OF EACH VARIABLE WITH ALL OTHER VARIABLES

Variables	SMC
1. Offers constructive ideas	0.99588
2. Provides assistance	0.99377
3. Goes beyond bare requirements	0.99418
4. Behavior causes favorable reaction	0.99653
5. Has confidence of superiors	0.98596
6. Has confidence of peers	0.99366
7. Objects to ideas before explained	0.98317
8. Refuses suggestions or advice	0.98028
9. Avoids criticism by blaming others	0.99275
10. Tends to approach things in own way	0.97613
11. Takes initiative in group meetings	0.97642
12. Offers constructive ideas to others	0.99238
13. Attempts to expand knowledge	0.99373
14. Communicates ideas with conviction	0.94991
15. Distinguishes problems importance	excluded
16. Establishes work priorities	0.99286
17. Takes action based on importance	excluded
18. Considers alternatives of action	0.98912
19. Gives poor presentations	0.98276
20. Dull monotone speech	0.99307
21. Speaks clearly before groups	0.99241
22. Prepares incomplete reports	0.98574
23. Does not limit thinking to self	excluded
24. Works with people outside department	0.99287
25. Keeps objectives of firm in mind	0.94282
26. Fails to communicate across depts.	0.99568
27. Will attempt new methods	0.99668
28. Adapts readily to new situations	0.99293
29. Does not keep current in field	0.99205
30. Enthusiastic in new work assignments	0.99511
31. Gives attention to detail	excluded
32. Is accurate in work	0.97521
33. Uses scientific approach	0.98917
34. Is not thorough in approach	0.98915
35. Makes illogical assumptions	0.99190
36. Difficulty in meeting deadlines	0.99441
37. Needs to be "pushed" to finish	excluded
38. Utilizes time available	0.98918
39. Will take initiative	0.98731
40. Hesitates to make decisions	0.99236
41. Will act on own initiative	0.93879
42. Works well under pressure	0.99656
43. Uses good judgment	excluded

After rotation, the amount of variance explained in nine factors was altered as seen in table 7. However, the general factor was comprised of only eight highly loading variables instead of the high loading of all variables on the first factor experienced in the unrotated examination. These eight variables were questions number 3, 4, 5, 7, 8, 20, 34, and 40. By employing the criterion for determining the number of factors to retain, discussed earlier in this chapter, rotation ceased after the generation of nine factors.

TABLE 7

VARIANCE EXPLAINED BY EACH FACTOR
WITH VARIMAX ROTATION

Factor	Variance Explained (Eigenvalue)	Cumulative Proportion of Total Variance
1.	5.957	0.161
2.	4.044	0.270
3.	3.930	0.376
4.	3.573	0.473
5.	3.564	0.569
6.	3.147	0.654
7.	2.199	0.713
8.	1.624	0.757
9.	1.492	0.797

The rotated loadings are the regression coefficients for predicting the variables from the factors. Since the rotation was orthogonal, these loadings are also the correlations of the variables with the rotated factors. These rotated loadings can be compared with the unrotated loading

to reveal the objective of rotation; the larger loadings are larger than before and the smaller loadings are smaller than before. The sorted, varimax rotated factor loadings for the the first five factors of the principal components analysis are shown in table 8. Subjective factor names were assigned based on the frequency and strength of the behavioral variables that loaded on any one factor. The five names chosen are as follows: (1) collaboration, (2) constructive decisiveness, (3) thoroughness and accuracy, (4) flexibility, and (5) openness to influence. The sorted and unsorted orthogonally rotated factor loadings for the complete principal components analysis are contained in appendix 3. The result of this rotated factor analysis was to reduce the data to a group of eight variables for future discriminant analysis.

TABLE 8

SORTED ROTATED FACTOR LOADINGS
FOR PRINCIPAL COMPONENTS ANALYSIS
(VARIMAX ROTATION)

Question number	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5
Q-3	0.831				
Q-6	0.777				
Q-18	0.748				
Q-2	0.743				
Q-5	0.714				
Q-1	0.635				
Q-32	0.598				
Q-38	0.563				
Q-39		0.825			
Q-41		0.781			
Q-11		0.729			
Q-40		-0.702			
Q-14		0.630			
Q-34			0.818		
Q-36			0.753		
Q-22			0.686		
Q-35			0.676		
Q-16			-0.659		
Q-27				0.797	
Q-28				0.745	
Q-30				0.684	
Q-24				0.544	
Q-8					0.799
Q-7					0.798
Q-9					0.795
Q-10					0.726

Questions fifteen, seventeen, twenty-three, thirty-one, thirty-seven, and forty-three were excluded from the study.

Conclusions

The general factor of the unrotated analysis included thirty-seven variables which accounted for thirty-five percent of the total variance, whereas the first factor of the rotated factor analysis explained sixteen percent of the variance with only eight variables. The following conclusions were drawn from this phase of the investigation:

1. Due to the high loading of all variables of the first unrotated factor, an apparent confirmation of the presence of a halo or rater bias phenomenon was experienced. Since rater bias or halo is an operative component in performance appraisal, this result is not surprising

2. Both the unrotated and rotated variables that loaded highly on the first factor will be the components in a discriminant analysis to investigate for a possible difference in the group means

3. Since all the variables are highly associated (all large SMC's), it could be expected that an analysis of the group means could conclude that little difference between the two groups exists

4. Factor names were easily chosen for the first five factors of the rotated factor analysis due to the high loadings of behavioral variables from the already established behavioral categories appearing on the survey questionnaire. As an example, only those behavioral variables in the openness to influence category contained in the survey instrument loaded highly on factor 5

Due to the ordinal nature of the data produced from employment of the Likert scale, the enlistment of a nonparametric test of statistical significance was desired prior to the discriminant analysis inquiry. The sign test was chosen for this role, since is it commonly used to determine if there is a statistically significant difference between two sets of metric or nonmetric responses.

Sign Test

The nonparametric sign test derives its name from the fact that it relies on plus (+) and minus (-) signs rather than quantitative measures as its data. It is not only useful for research in which quantitative measurement is impossible or infeasible, but in cases where it is possible to rank with respect to each other the two members of each pair. Like other bivariate methods that analyze relationships between two variables, the sign test is especially well suited to behavioral analysis. The sign test is an applicable tool for use when the experimenter wishes to establish that two conditions are different for two related samples. The only requirement imposed is that each pair achieve matching with respect to the relevant extraneous variables. Since this study consists of fifty matched performance appraisals of two groups of similarly placed workers, the sign test is an appropriate means of investigation.

Methodology. The null hypothesis tested by the sign test[84] is that

$$p(X_a > X_b) = p(X_a < X_b) = 0.50$$

where X_a is the judgment or score under one of the conditions and X_b is the judgment or score under the other condition. Therefore, X_a and X_b are the two "scores" for a matched pair. For the duration of this study, the scores

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[84]Sidney Siegel, Nonparametric Statistics For The Behavioral Sciences (New York: McGraw-Hill, 1956), pg. 68.

for the X_a condition apply to the impaired individual or group and those for the X_b condition refer to the non-impaired individual or group. Accordingly, another way of stating H_0 is: the median difference is zero. Since the sign test focuses on the direction of the difference between every X_{ai} and X_{bi}, if the null hypothesis were true, one would expect about half the differences to be negative and half to be positive. Naturally, H_0 is rejected if too few differences of any one sign occur.

Testing the hypothesis. The probability of a number of pluses (+'s) and minuses (-'s) occurring can be determined by reference to the binomial distribution with $P = Q = 0.50$, where N = the number of pairs.[85] If a matched pair shows no difference (i.e., the difference, being zero, has no sign) it is dropped from the analysis and N is thereby reduced. Appendix 4 contains a listing of a computer program written to calculate the probabilities associated with the occurrence under H_0 of values of x, where x is the number of fewer signs.

Single performance variable application

A sign test was performed on each of the forty-three behavioral variables. The results, which are summarized in table 9, show that a significant difference in the performance of the two groups appeared on questions eight, nine, eleven, thirty-nine and forty-two. These variables were

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[85]Ibid., pg. 69.

TABLE 9

SIGN TEST RESULTS OBTAINED FROM ANALYSIS OF FORTY-THREE BEHAVIORAL VARIABLES

Variable	Value of N	Value of X	One-tailed Probability	Two-tailed Probability
Q-1	25	11	.345	.690
Q-2	22	9	.262	.523
Q-3	25	11	.345	.690
Q-4	23	10	.339	.678
Q-5	26	12	.423	.845
Q-6	25	9	.115	.230
Q-7	26	9	.084	.169
Q-8	26	6	.005 *	.009 *
Q-9	24	6	.012 *	.023 *
Q-10	31	12	.141	.281
Q-11	24	6	.012 *	.023 *
Q-12	21	10	.500	1.000
Q-13	25	11	.345	.690
Q-14	32	16	.570	1.140
Q-15	25	11	.345	.690
Q-16	24	11	.419	.838
Q-17	26	11	.279	.557
Q-18	24	12	.581	1.161
Q-19	14	6	.395	.791
Q-20	15	5	.151	.302
Q-21	14	4	.090	.180
Q-22	18	9	.593	1.186
Q-23	27	10	.124	.248
Q-24	15	7	.499	.999
Q-25	23	9	.202	.405
Q-26	20	8	.252	.503
Q-27	25	9	.115	.230
Q-28	27	13	.500	1.000
Q-29	24	11	.419	.839
Q-30	17	5	.072	.144
Q-31	24	11	.419	.839
Q-32	28	13	.425	.851
Q-33	25	10	.212	.424
Q-34	27	10	.124	.248
Q-35	28	12	.286	.572
Q-36	30	15	.572	1.144
Q-37	29	11	.132	.265
Q-38	30	12	.181	.361
Q-39	17	4	.025 *	.049 *
Q-40	24	11	.419	.839
Q-41	25	8	.054	.108
Q-42	28	8	.018 *	.036 *
Q-43	22	11	.584	1.168

* significant difference at the .05 level

subjected to a discriminant analysis that is described later in this chapter. An example of the tabulation involved in this phase of the research is included in appendix 4 along with the program listing to calculate the one and two-tailed probabilities. The results of these tabulations are depicted graphically in figures 10 through 20. These graphs are arranged according to the behavioral categories as they appeared on the research questionnaire that is included in appendix 2.

Overall performance application

Additionally, a sign test was applied to the the overall results of the preceding phase of this research. That is, a sign test was performed on the favorable/unfavorable to impaired worker sign test score on each of the forty-three behavioral variables. Each question was analyzed based on the number of pluses (+) and minuses (-) received by the two groups. These values were then transformed into a favorable (+) or unfavorable (-) rating to the impaired worker group based on the point-of-view of the individual behavioral items. This represented an overall favorable or unfavorable performance assessment of the impaired group in contrast to the non-impaired group. Table 9 summarizes the results, which point to the fact that no significant difference exists between the two groups level of performance. Again, the probability was directly calculated using the program shown in appendix 4.

TABLE 10

SIGN TEST BASED ON OVERALL FAVORABLE/UNFAVORABLE TO IMPAIRED WORKERS SCORE

Item #	Plus (+)	Minus (-)	Neutral (0)	Item #	Plus (+)	Minus (-)	Neutral (0)
1	+			23		-	
2		-		24		-	
3	+			25		-	
4	+			26		-	
5	+			27	+		
6		-		28	+		
7	+			29	+		
8	+			30	+		
9	+			31		-	
10	+			32	+		
11		-		33		-	
12	+			34		-	
13	+			35	+		
14			0	36			0
15		-		37	+		
16		-		38		-	
17		-		39		-	
18			0	40		-	
19		-		41		-	
20		-		42		-	
21		-		43			0
22			0				

Favorable (+) $X_a > X_b = 17$
Unfavorable (-) $X_a < X_b = 21$
Tied (0) $X_a = X_b = 5$
N = 38, x = 17, probability (p) = .314

Conclusion

The application of the nonparametric sign test to the fifty matched supervisory ratings proved a useful, although a more qualitative, analysis of the data. The following conclusions were drawn from this phase of the project:

1. Based on the results reported in table 10, overall performance may not differ between the two groups

2. When the investigative attention is turned to individual questions, significant differences do appear. In the case of the sign test criteria, questions eight, nine, eleven, thirty-nine, and forty-two yielded significant results. These questions appeared in the openness to influence, constructive initiative, and decisiveness behavioral categories as shown in table 9. Two were favorable and three were unfavorable to the impaired workers

The results of the sign test led to a later discriminant analysis of variables eight, nine, eleven, thirty-nine, and forty-two.

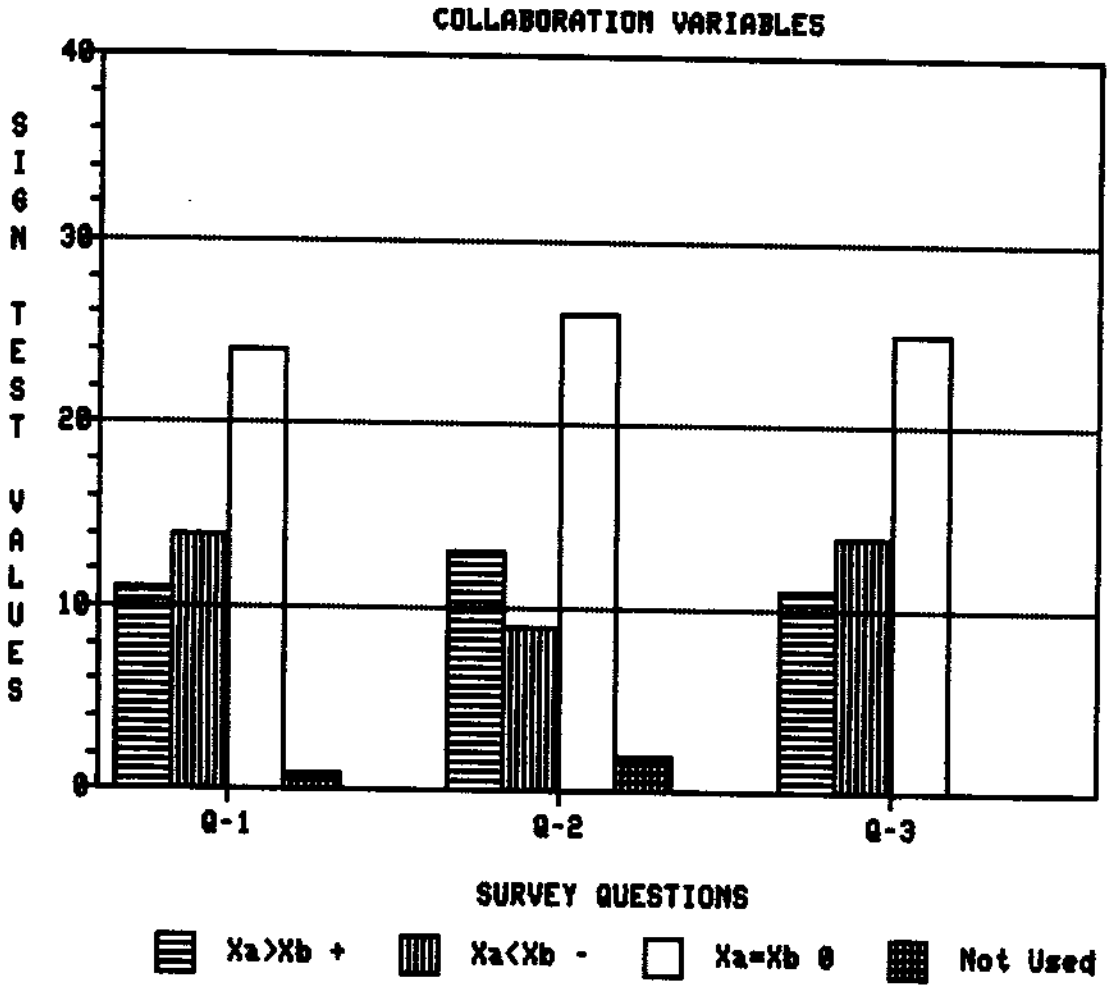

Fig. 10. Collaboration variables

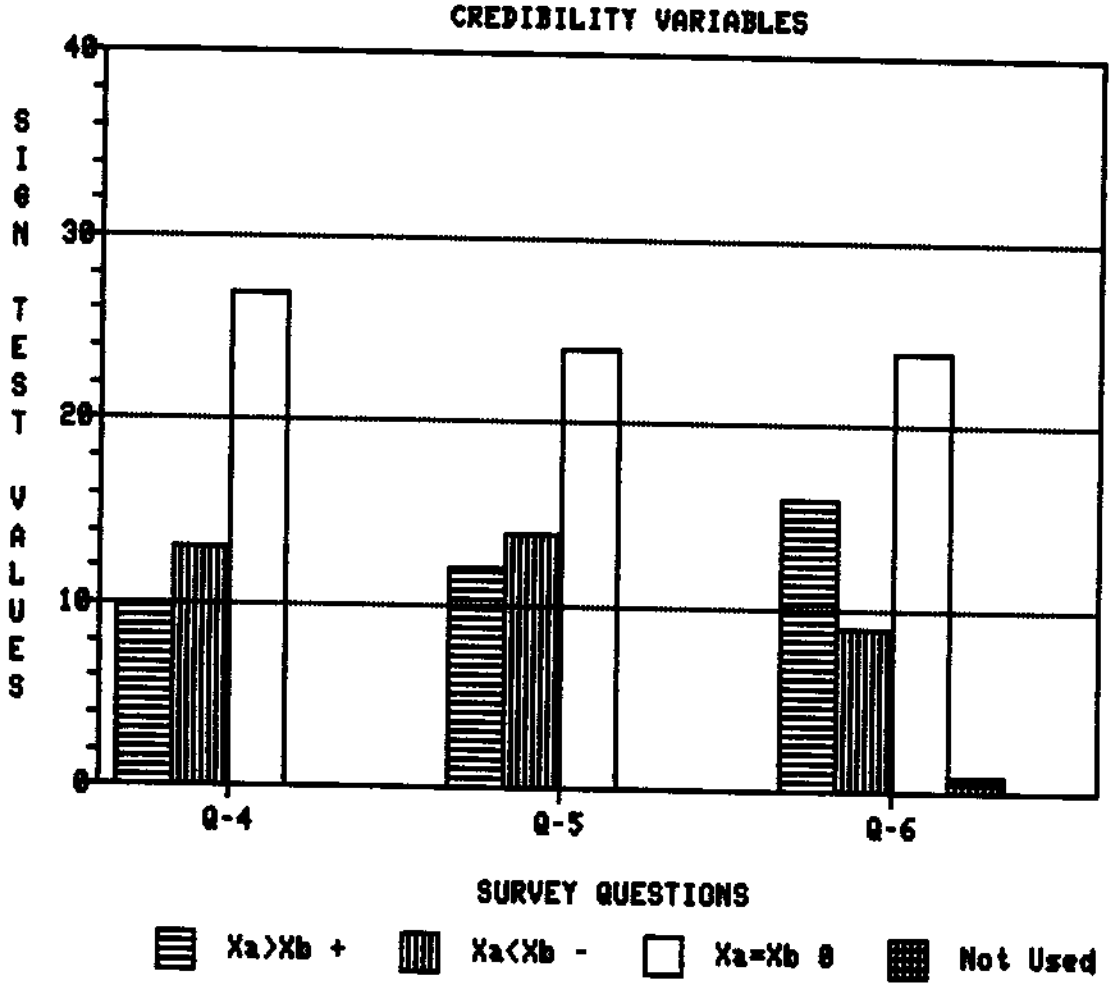

Fig. 11. Credibility variables

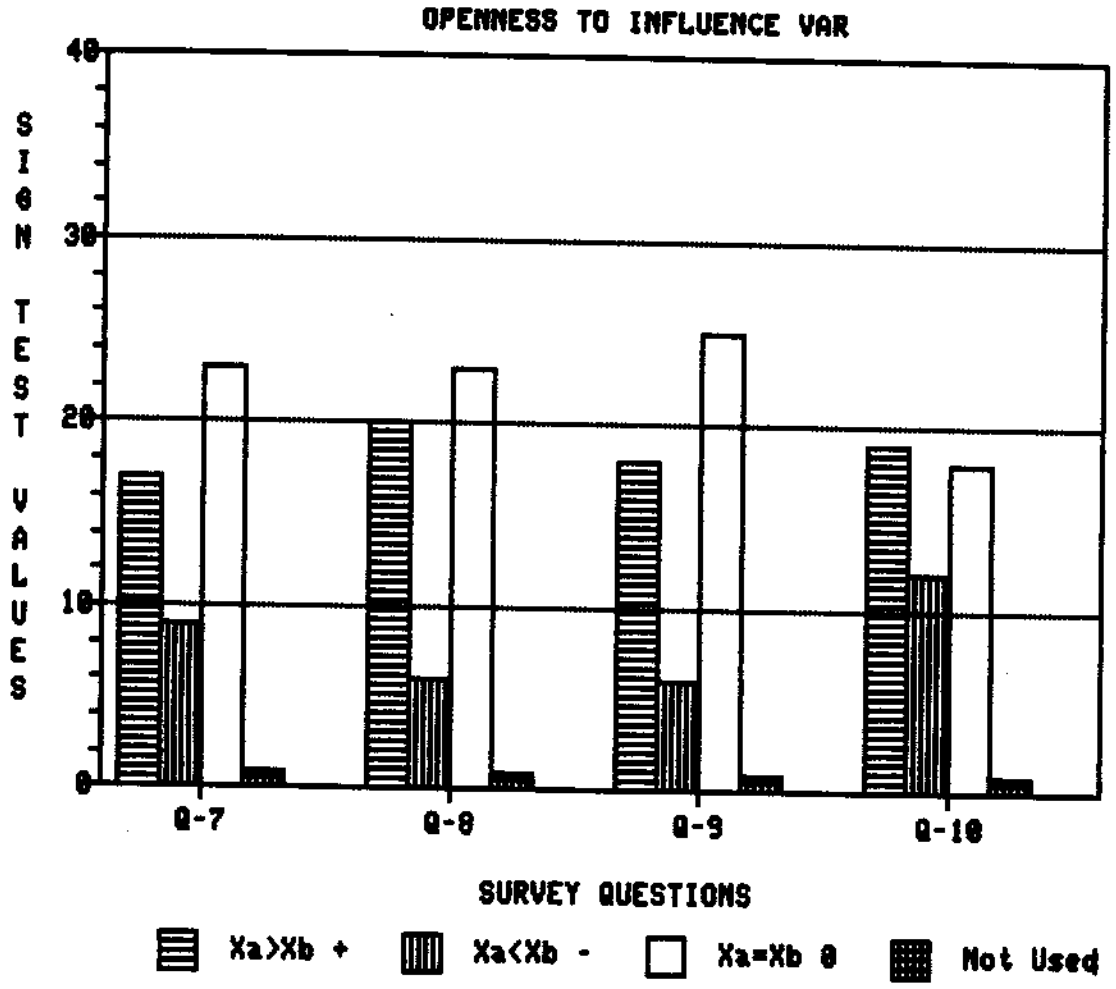

Fig. 12. Openness to influence variables

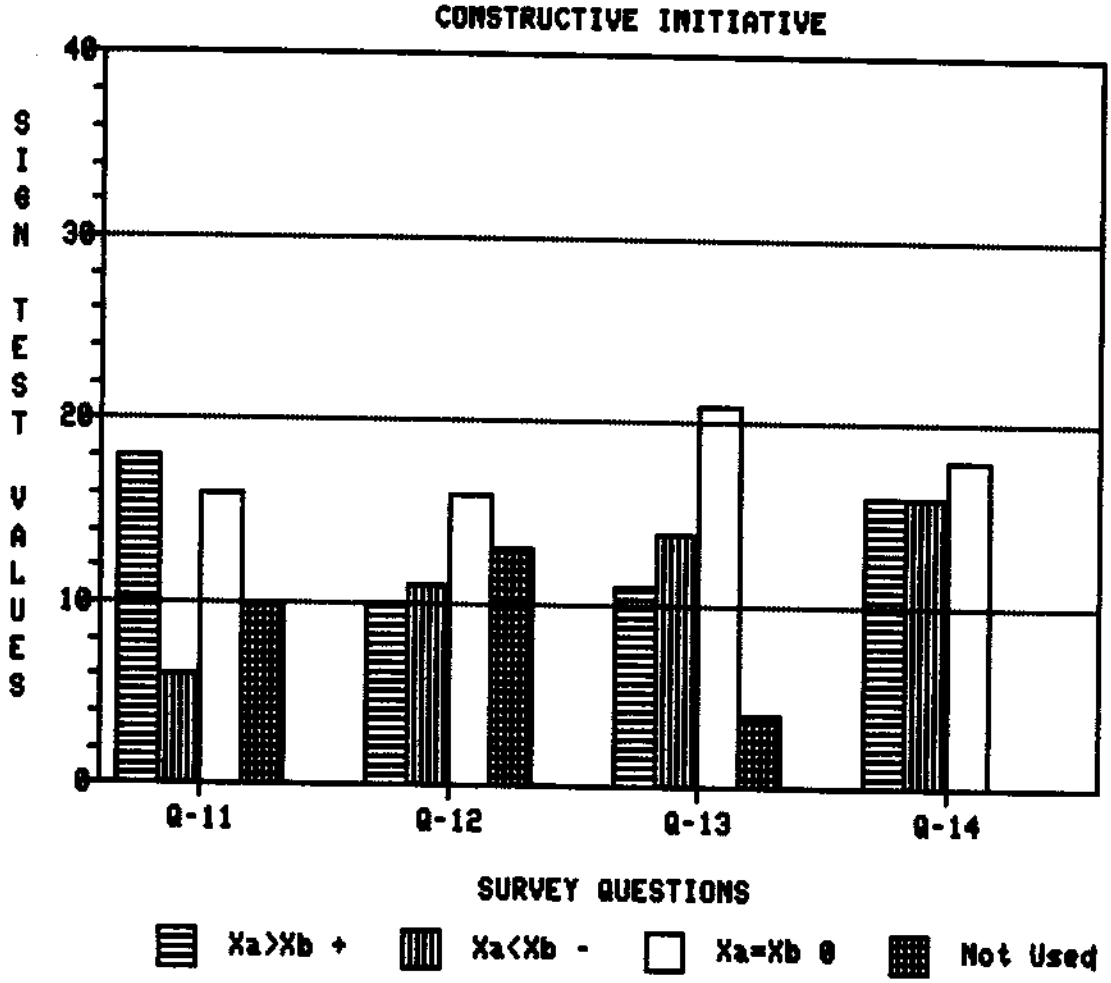

Fig. 13. Constructive initiative

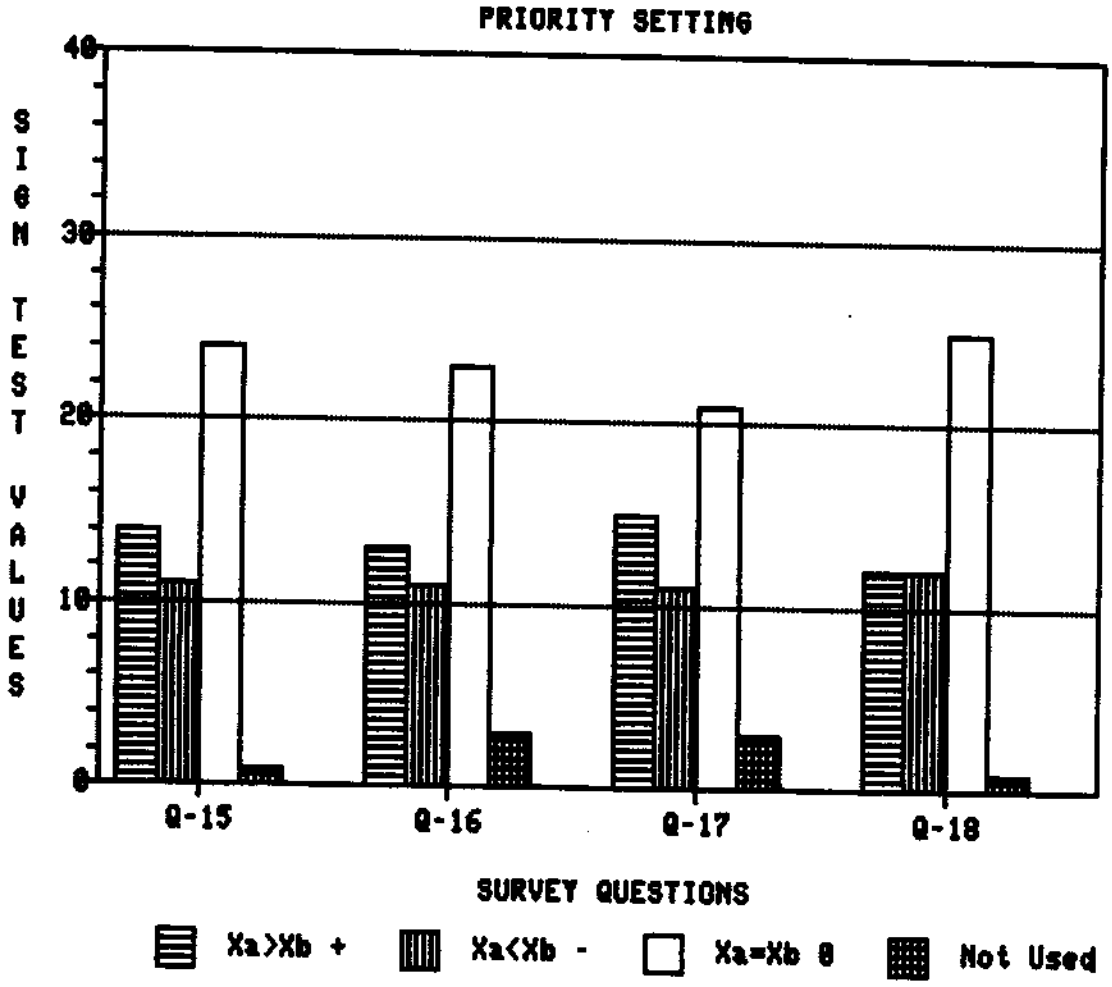

Fig. 14. Priority setting

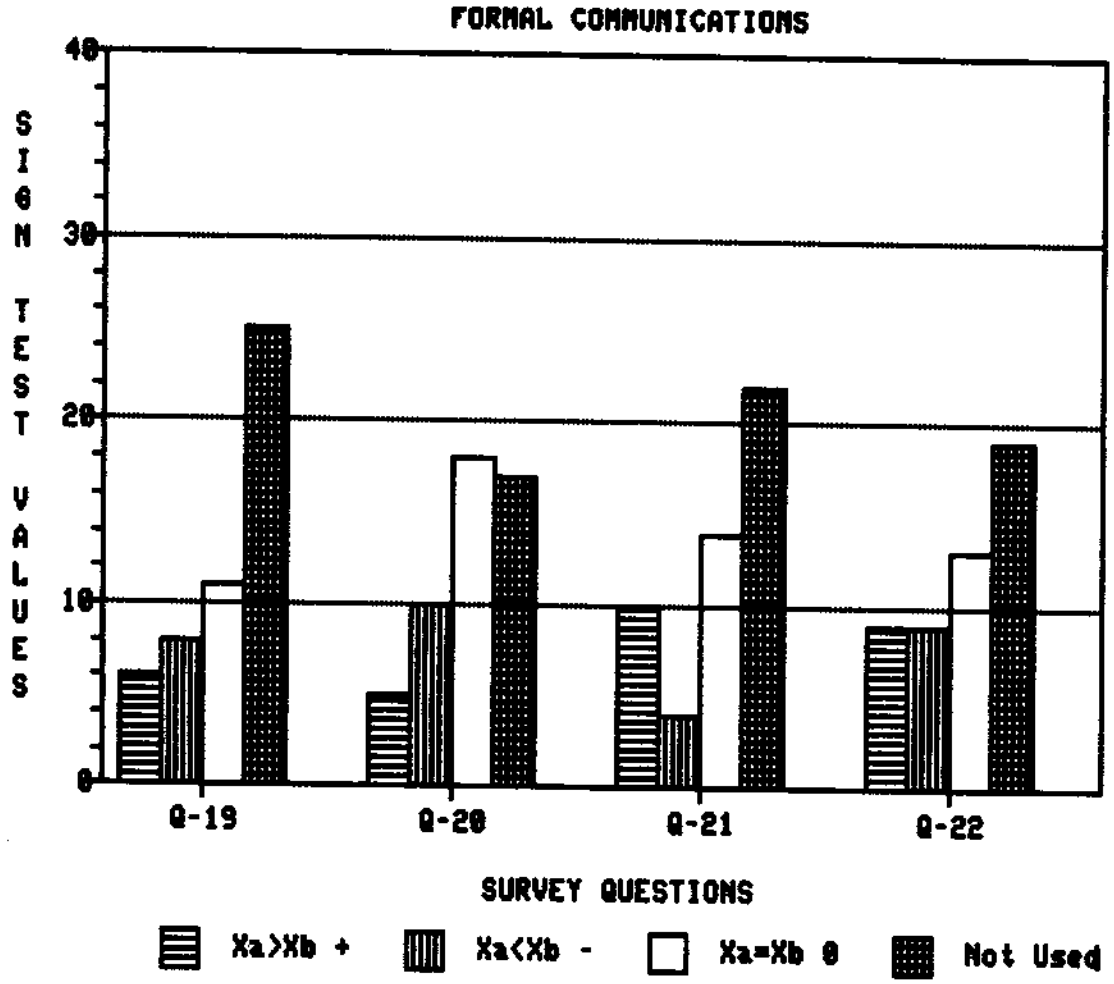

Fig. 15. Formal communications

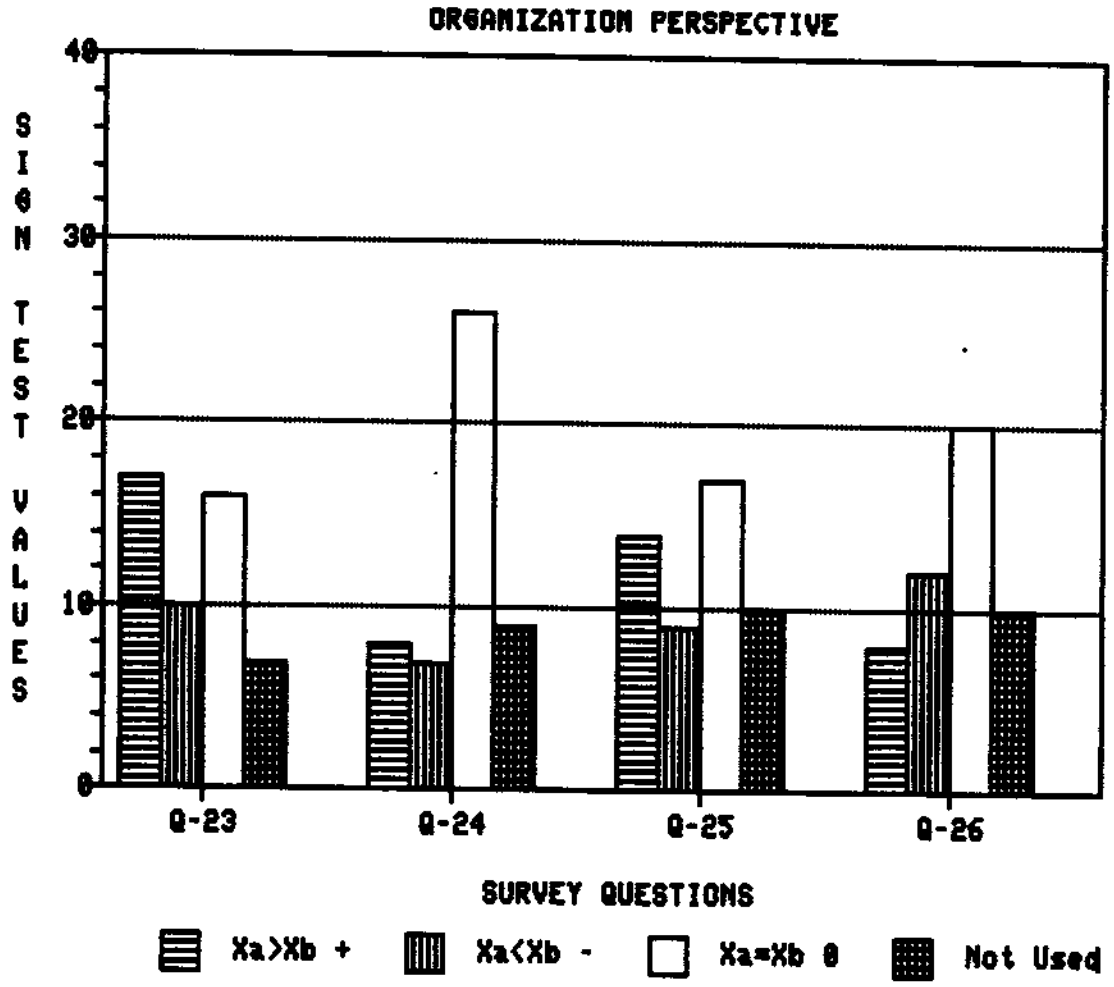

Fig. 16. Organization perspective

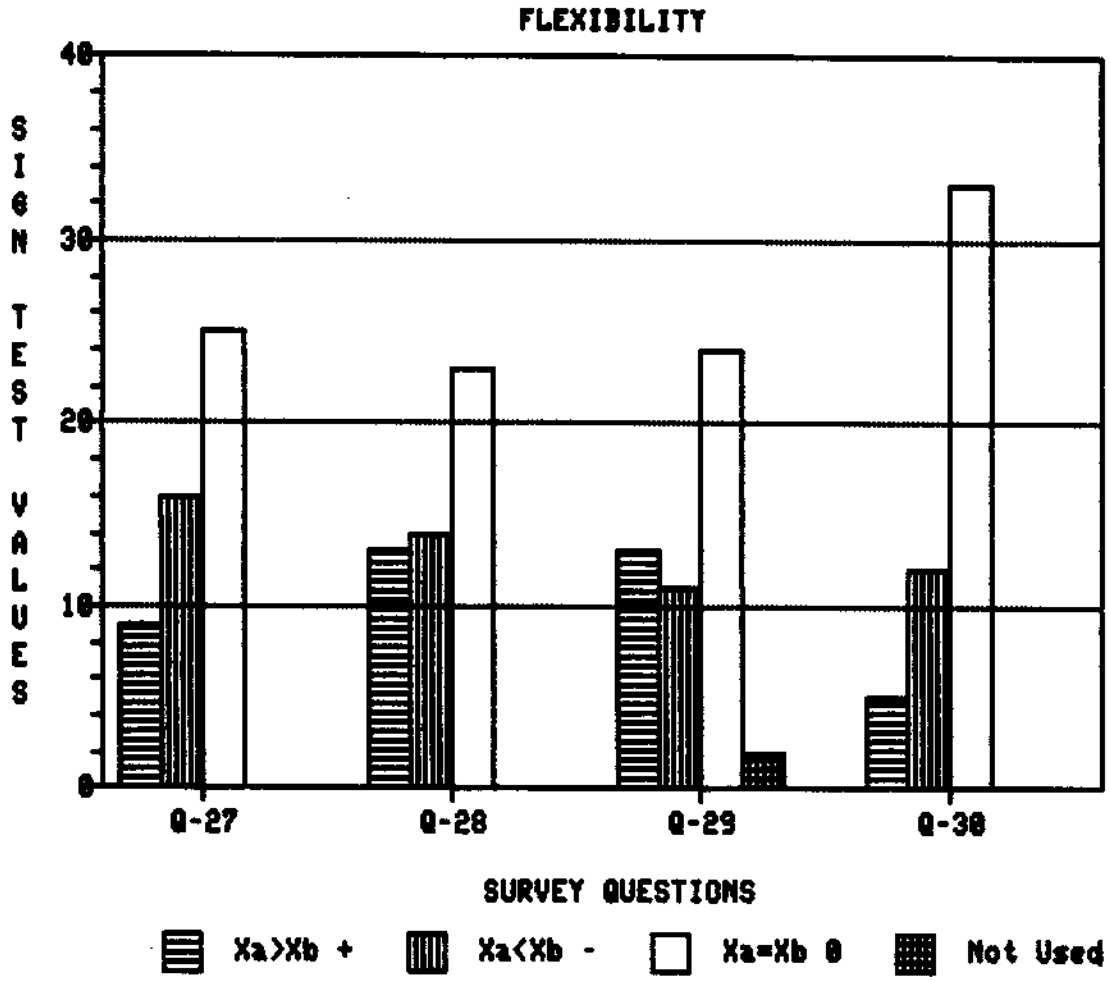

Fig. 17. Flexibility

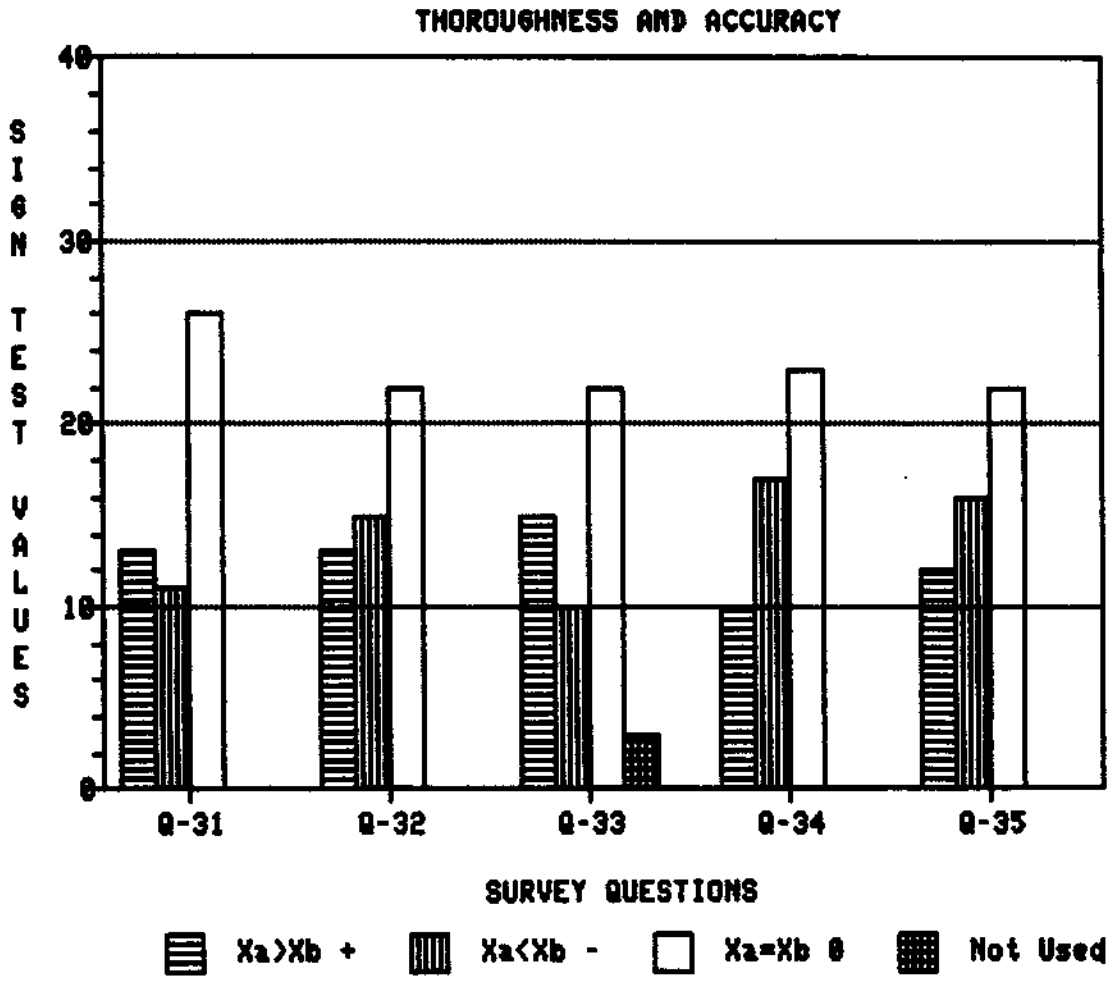

Fig. 18. Thoroughness and accuracy

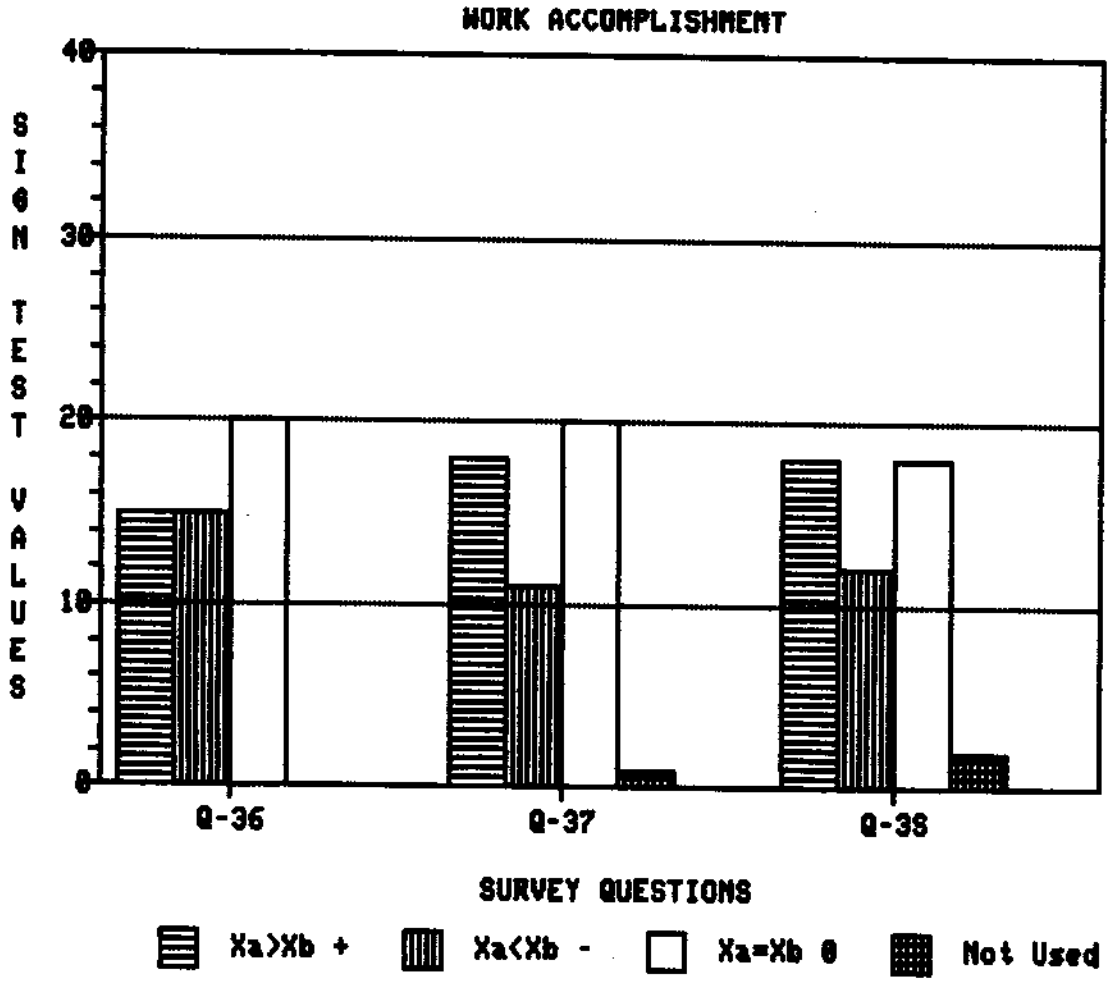

Fig. 19. Work accomplishment

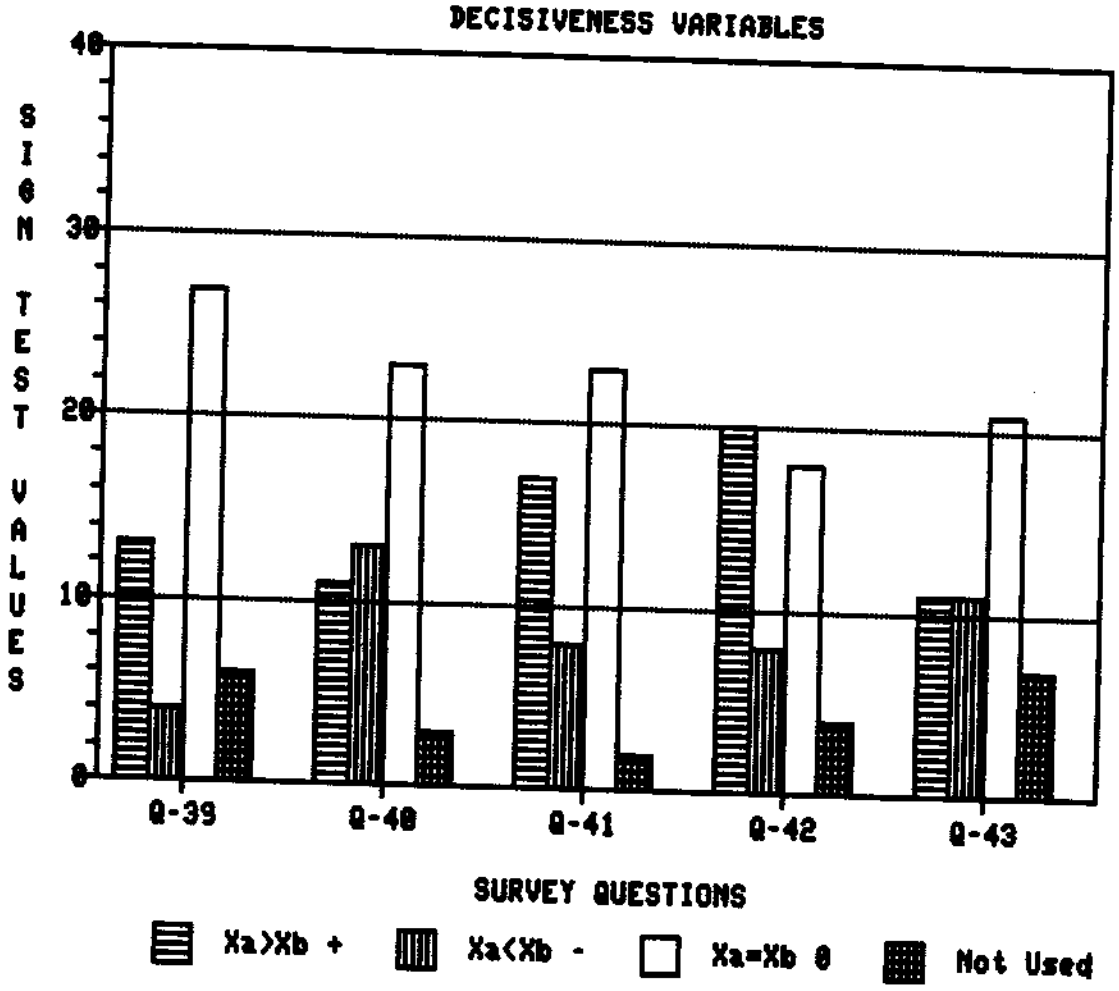

Fig. 20. Decisiveness

Discriminant Analysis

Discriminant analysis is a powerful technique for investigating differences between two or more groups of objects with respect to several variables. The technique is very similar to regression. As in regression analysis, discriminant analysis attempts to predict a dependent variable as a function of a set of independent variables. The major difference between the discriminant and regressive techniques is that in discriminant analysis, the dependent variable is assumed to be categorical (e.g., impaired or non-impaired worker). Consequently, the impetus of discriminant analysis is to predict group membership, and when employing the multivariate F statistic, to test for the differences between two groups. It is the aspect of testing for differences between groups that is of interest to this study, since it reports the performance of two groups and tests the hypothesis that the group means are equal. Joseph F. Hair describes the technique:

> . . . Discriminant analysis involves deriving the linear combination of the two (or more) independent variables that will discriminate best between the a priori defined groups. This is achieved by the statistical decision rule of maximizing the between-group variance relative to the within-group variance--this relationship is expressed as the ratio of the between-group to within-group variance. The linear combinations for a discriminant analysis are derived from an equation which takes the following form:
>
> $$Z = W_1X_1 + W_2X_2 + W_3X_3 + \ldots + W_nX_n$$
>
> where
>
> Z = the discriminant score
> W = the discriminant weights

X = the independent variables[86]

The weight assigned a particular variable depends on the difference in means between the two groups on that variable and the variance of that variable. This indicates that variables on which the two groups differ significantly will be weighted heavily by the discriminant function. The resulting discriminant function can be used to classify observations. However, this predictive or classification capability is not utilized in this study.

The F distribution

The F distribution is a continuous probability distribution that was developed in 1924 by the English statistician R. A. Fisher. This distribution is employed in two important applications. First, the F distribution serves as the basis of analysis of variance techniques. These methods are extremely useful tools and possess applicability to a variety of fields. Second, and of greatest importance to this study, the F distribution will enable one to test the equality of two population variances, H_0: $\sigma_1^2 = \sigma_2^2$. When using the Student's t distribution to test H_0: $u_1 - u_2 = 0$ or $u_1 = u_2$, it is necessary to make the assumption of equal variances. The F distribution provides a check on the validity of this assumption and can test for the equality of two or more population means. It is a theoretical proba-

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[86]Joseph F. Hair et al., Multivariate Data Analysis (Tulsa: Petroleum Publishing Company, 1979), pg. 85

bility distribution which measures the probablity that a difference in group means observed in the sample is due to chance sampling variation when, in fact, there is no difference in the population. The distribution has a different shape depending on the degrees of freedom associated with the particular problem. One must know the degrees of freedom before consulting a table to determine the probability level associated with the computed F value. The BMDP7M discriminant analysis program used in this analysis employs the F statistic to test for the differences between the groups.

Inclusion of variables

In this exploratory investigation discovering the most useful variables to include in a discriminant analysis is not clear cut. The approach taken employed the data reduction power of factor analysis and the application of the sign test to point to useful discriminating variables. The discriminant analysis of these identified variables proceeded along two optional courses. One way was to eliminate further unnecessary variables by using a stepwise procedure to select the most useful discriminating variables. Any stepwise procedure must employ some measure of discrimination as the criterion for selection. The BMDP7M program employed in this investigation required a variable to pass certain minimum conditions before it is tested on the selection criteria. These conditions are a tolerance test to assure computational accuracy and a partial F statistic to

assure that the increased discrimination exceeds some level determined by either the user or some predefined standard. Finally, selection, usually based on the multivariate F statistic for the test of group differences, is made. The purpose of the stepwise selection is to locate a more convenient subset of variables which can discriminate well.

A second method of including variables in the discriminant analysis is to force all or some of the variables, which the researcher believes to have discriminating potential, into the investigation. Both the forcing of variables into the analysis and the use of a stepwise procedure to select discriminating variables were employed in this study. The results of this approach to the analysis of the data collected for forty-three behavioral variables is discussed below.

Analysis with variables from unrotated PCA

Tables 11 and 12 show a summary of the results of a stepwise and an all variables forced into the analysis discriminant study. The outcomes depict that a significant difference exists between the two groups. However, on close investigation, certain factors may explain these findings. Two of these factors could include (1) the already determined high degree of colinearity that exist in the data, and perhaps of more importance, (2) the inclusion of only 38 of the original 100 cases for use in the investigation.

TABLE 11

STEPWISE DISCRIMINANT ANALYSIS OF
UNROTATED PCA VARIABLES

Step Number	Variable Entered	Approximate F-statistic	Degrees of freedom	
			numerator	denominator
1	Q-25	6.540	1	36
2	Q-8	7.464	2	35
3	Q-42	7.985*	3	34

$P(F_{3,34} > 2.81) = 0.05$

Number of cases = 100
Cases with data beyond limits = 62
Remaining number of cases = 38

NOTE: Variables # 15, 17, 23, 31, 37, and 43 were omitted in accordance with the results of the original factor study reported earlier in this paper.

*This and all previous steps significant at the .05 level

TABLE 12

DISCRIMINANT ANALYSIS OF UNROTATED PCA VARIABLES
(ALL VARIABLES FORCED INTO THE ANALYSIS)

Step Number	Variable Entered	Approximate F-statistic	Degrees of freedom	
			numerator	denominator
1	Q-25	6.540	1	36
2	Q-8	7.464	2	35
3	Q-42	7.985	3	34
4	Q-6	6.919	4	33
5	Q-38	8.795	5	32
6	Q-9	8.165	6	31
7	Q-18	7.798	7	30
8	Q-39	7.759	8	29
9	Q-22	7.708	9	28
10	Q-40	8.141	10	27
11	Q-29	8.229	11	26
12	Q-5	7.827	12	25
13	Q-24	7.986	13	24
14	Q-13	7.988	14	23
15	Q-33	7.616	15	22
16	Q-20	7.355	16	21
17	Q-19	7.984	17	20
18	Q-14	7.946	18	19
19	Q-11	7.666	19	18
20	Q-34	8.315	20	17
21	Q-26	9.391	21	16
22	Q-36	10.927	22	15
23	Q-41	10.853	23	14
24	Q-1	12.121	24	13
25	Q-30	12.361	25	12
26	Q-27	11.912	26	11
27	Q-32	12.006	27	10
28	Q-4	13.877	28	9
29	Q-28	12.396	29	8
30	Q-35	10.528	30	7
31	Q-10	8.747*	31	6

$P(F_{3,34} > 2.41) = 0.05$

Number of cases = 100
Cases with data beyond limits = 62
Remaining number of cases = 38

NOTE: Variables # 15, 17, 23, 31, 37, and 43 were omitted in accordance with the results of the original factor study reported earlier in this paper.

*This and all previous steps significant at the .05 level

By including all variables in the analysis, a large percentage of the performance ratings were excluded. This is due to the fact that cases where raters exercised the option of responding "not relevant" to their evaluation of either the impaired or non-impaired worker were omitted from the analysis. One interpretation of the "not relevant" score is that it reflects the degree of rater strictness or leniency. Here, a rater that chose another option would be considered a strict performance evaluator, whereas a supervisor that employed the "not relevant" score would be considered lenient in his interpretation of worker performance.

Table 13 provides a detail of the frequency that a supervisor responded "not relevant" to all behavioral questions included in the survey. The table illustrates that of the 129 "not relevant" responses, the majority were issued in reference to the performance level of the impaired employee. Table 14 summarizes these "not relevant" supervisory ratings into two groups: (1) one containing matched not relevant responses (balanced ratings), and (2) one containing unbalanced "not relevant" responses.

Further attention is given to the direction of the unbalanced performance evaluations in table 15. This view of the unbalanced ratings depicts a large percentage difference in the manner in which supervisors exercised the "not relevant" option. Of the sixty-six unbalanced ratings almost ninety-seven percent were assigned to the impaired employee.

TABLE 13

FREQUENCY OF SUPERVISORY NOT RELEVANT RESPONSES
ON EACH BEHAVIORAL QUESTION

Question Number	Frequency of Not Relevant Response for Impaired	Frequency of Not Relevant Response for Non-Impaired	Total Frequency	Frequency of Matched Not Relevant Responses
2	2	0	2	0
7	1	0	1	0
8	1	0	1	0
9	1	0	1	0
10	1	0	1	0
11	8	3	8	3
12	8	3	8	3
13	2	0	2	0
16	1	1	1	1
17	1	0	1	0
18	1	0	1	0
19	19	14	20	13
20	15	9	15	9
21	18	10	18	10
22	13	10	13	10
23	6	2	6	2
24	8	4	9	3
25	8	3	8	3
26	8	5	8	5
29	1	1	1	1
39	1	0	1	0
40	1	0	1	0
41	1	0	1	0
43	1	0	1	0
TOTAL	127	65	129	63

Variables 1, 3-6, 14-15, 27-28, 30-38 and 42 contained no supervisory "not relevant" responses.

TABLE 14

TYPES OF SUPERVISORY NOT RELEVANT RATINGS

Type of Supervisory Rating	Frequency of Occurrence	Percentage of Total
Unbalanced Rating . . . . . (not relevant response occurs for only one employee)	66	51.16
Balanced Rating . . . . . (not relevant response occurs for both employees)	63	48.84
TOTALS	129	100.00

TABLE 15

UNBALANCED SUPERVISORY NOT RELEVANT RATINGS

Direction of the Unbalanced Not Relevant Rating	Frequency of Occurrence	Percentage of Total
Toward the Impaired Worker . (not relevant response occurs only for this employee)	64	96.67
Toward the Non-Impaired Worker . . . . . (not relevant response occurs only for this employee)	2	3.03
TOTALS	66	100.00

Tables 16 and 17 portray the frequency of supervisory "not relevant" responses on the basis of matched pair evaluations, rather than on the previous individual behavioral variables shown in tables 13, 14 and 15. Of special interest to the issue of rater leniency or strictness is the

recognition of the disproportionate percentage of "not relevant" ratings that were reported for the impaired worker.

Another possible explanation for a supervisor utilizing the "not relevant" option is that this represents the choice not to rate the employee on this particular behavioral variable. The information that comprises tables 16 and 17 amplifies this possibility. Of the fifty participating supervisors, twenty-nine (fifty-eight percent) chose not to rank employees in at least one behavioral area. If one scrutinizes the occurrences where the rater exercised the option not to rank subordinates in an equal manner, eighty percent of the choices were not to rank the impaired worker and to rate the non-impaired co-worker. This leads to an inference that the predominate motive for not ranking was leniency towards the impaired worker.

Since this segment of the research essentially excluded all lenient ratings, a somewhat skewed population sample containing only strict supervisory evaluations remained for the actual analysis. It seems logical that when limited to such ratings, a significant difference would appear. However, since there exists more than one type of supervisor, further investigation that includes a more representative group of the data collected was undertaken.

TABLE 16

NUMBER OF PAIRED SUPERVISORY CASES CONTAINING A NOT RELEVANT RESPONSE

Type of Matched Case	Frequency of Occurrence	Percentage of Total
Cases containing a not relevant response . . .	29	58.00
Cases without a not relevant response . . .	21	42.00
TOTALS	50	100.00

TABLE 17

SUMMARY OF THE UNBALANCED SUPERVISORY CASES CONTAINING A NOT RELEVANT RESPONSE

Direction of the Unbalanced Not Relevant Rating	Frequency of Occurrence	Percentage of Total
Toward the Impaired Worker . (not relevant response occurs only for this employee)	8	80.00
Toward the Non-Impaired and Impaired Worker . . . . . (not relevant response occurs for both employees)	2	20.00
Toward the Non-Impaired Worker . . . . . (not relevant response occurs only for this employee)	0	00.00
TOTALS	10	100.00

Analysis with variables from rotated PCA

Using variables identified in an earlier principal components factor analysis employing orthogonal rotation, another discriminant investigation was undertaken. The eight variables included were Q-1, Q-2, Q-3, Q-5, Q-6, Q-18, Q-32, and Q-38. Both a stepwise procedure and one where all variables were forced into the analysis were employed.

The stepwise procedure resulted in no variables entering the analysis. Table 18 shows step number 0 in the discriminant procedure, and the associated low values for the F-to-enter. For a variable to be entered, an F value greater than or equal to 4.000 is required. This value (a partial multivariate F statistic) tests the additional discrimination introduced by the variable. When the value is small (less than 4.00 in the stepwise case), the variable is not selected because it is not adding enough to the overall discrimination.

TABLE 18

STEPWISE DISCRIMINANT ANALYISIS
ROTATED PCA VARIABLES

Step Number	Variable	F-To-Enter	Force Level	Degrees of Freedom
0	Q-1	0.182	1	num = 1
	Q-2	1.379	1	dem = 91
	Q-3	0.027	1	
	Q-5	0.115	1	
	Q-6	1.658	1	
	Q-18	0.150	1	
	Q-32	0.570	1	
	Q-38	1.991	1	

NO VARIABLES ENTERED

Number of cases = 100
Cases with data beyond limits = 7
Remaining number of cases = 93

Table 19 provides a summary of the results of a discriminant analysis that included the eight variables discussed above once they were forced into the analysis (F-to-enter values are relaxed). No significant difference appeared during this phase of the study. However, it is important to note that a large percentage (ninety-three) of the supervisory ratings were included in this portion of the investigation. This suggests that the inclusion of the more lenient performance evaluations have offset the more strict ones which were isolated in the earlier discriminant analysis of the unrotated variables. Discriminating power has been reduced in an environment containing a more rich collection of supervisory types.

TABLE 19

DISCRIMINANT ANALYSIS OF ROTATED PCA VARIABLES
(ALL VARIABLES FORCED INTO THE ANALYSIS)

Step Number	Variable Entered	Approximate F-statistic	Degrees of freedom	
			numerator	denominator
1	Q-38	1.991	1	91
2	Q-5	2.187	2	90
3	Q-6	3.184	3	89
4	Q-1	2.914	4	88
5	Q-2	2.511	5	87
6	Q-3	2.196	6	86
7	Q-32	1.964	7	85
8	Q-18	1.725	8	84

$P(F_{8,84} > 2.068) = 0.05$
$P(F_{8,84} > 1.750) = 0.10$

Number of cases = 100
Cases with data beyond limits = 7
Remaining number of cases = 93

Analysis with variables from sign test

The discriminant analysis of the variables identified through use of the sign test can be divided into three areas: (1) a stepwise procedure including all five variables, (2) a focus on the variables that were favorable to the impaired workers, and (3) a focus on the variables that were identified to be favorable to the non-impaired worker. Tables 20, 21, 22, and 23 report the results. These variables differ significantly between the impaired and non-impaired groups. A brief discussion of these differences follows in the conclusion section of this chapter and in chapter 5.

TABLE 20

STEPWISE DISCRIMINANT ANALYSIS OF SIGN TEST VARIABLES

Step Number	Variable Entered	Approximate F-statistic	Degrees of freedom	
			numerator	denominator
1	Q-11	8.318	1	77
2	Q-42	6.491	2	76
3	Q-8	6.293*	3	75

$P(F_{3,75} > 2.740) = 0.05$

Number of cases = 100
Cases with data beyond limits = 21
Remaining number of cases = 79

*This and all previous steps significant at the .05 level

TABLE 21

STEPWISE DISCRIMINANT ANALYSIS OF SIGN TEST VARIABLES
(ALL VARIABLES FORCED INTO THE ANALYSIS)

Step Number	Variable Entered	Approximate F-statistic	Degrees of freedom	
			numerator	denominator
1	Q-11	8.318	1	77
2	Q-42	6.491	2	76
3	Q-8	6.293	3	75
4	Q-9	5.072	4	74
5	Q-39	4.054*	5	73

$P(F_{3,73} > 2.353) = 0.05$

Number of cases = 100
Cases with data beyond limits = 21
Remaining number of cases = 79

*This and all previous steps significant at the .05 level

TABLE 22

DISCRIMINANT ANALYSIS OF SIGN TEST VARIABLES
THAT WERE FAVORABLE TO THE IMPAIRED WORKER

Step Number	Variable Entered	Approximate F-statistic	Degrees of freedom	
			numerator	denominator
1	Q-9	3.264*	1	97
2	Q-8	2.008	2	96

$P(F_{2,96} > 3.102) = 0.05$
$P(F_{2,96} > 2.366) = 0.10$

Number of cases = 100
Cases with data beyond limits = 1
Remaining number of cases = 99

*Significant at the .05 level

TABLE 23

DISCRIMINANT ANALYSIS OF SIGN TEST VARIABLES
THAT WERE FAVORABLE TO THE NON-IMPAIRED WORKER

Step Number	Variable Entered	Approximate F-statistic	Degrees of freedom	
			numerator	denominator
1	Q-11	8.318	1	77
2	Q-42	6.491	2	76
3	Q-39	4.521*	3	75

$P(F_{3,75} > 2.740) = 0.05$

Number of cases = 100
Cases with data beyond limits = 21
Remaining number of cases = 79

*This and all previous steps significant at the .05 level

Conclusion

The discriminant portion of this research effort provided some degree of insight into the performance of two groups of similarly placed data processing employees, and

into the area of supervisory rater strictness. The analysis also confirmed earlier sign test findings that, on certain specific behavioral variables, significant differences exist between the performance evaluations of physically impaired and non-impaired co-workers.

Synthesis

The factor analytic, sign test and discriminant methods applied in this study have returned information of some worth regarding the performance of a group of physically impaired workers and their non-impaired co-workers. The following remarks are of special interest to the area of performance evaluation:

1. Overall performance as evaluated from a group containing both strict and lenient raters may not identify differences between two groups of workers

2. Overall performance as evaluated from a group containing only strict raters may more readily discriminate between groups of workers

3. A methodology of focusing on individual behavioral items within a multiple item supervisory rating instrument may yield areas of performance where significant differences between groups exist

These remarks could be utilized in training programs for both supervisors and workers, with the objectives of increasing communication between consecutive levels of the organization, and increasing worker performance at all levels of the organization.

CHAPTER V

SUMMARY AND CONTRIBUTIONS

This chapter contains an explanation of the acceptance of the null hypothesis followed by conclusions drawn from the results of the survey. A brief series of remarks on suggestions for future research efforts in the analysis of the performance level of physically impaired workers concludes the discussion.

Hypothesis

Central to this research endeavor was a comparison of the aggregate performances of both groups of workers through the use of factor and discriminant techniques. Data was collected to test the null hypothesis:

H_0 There is no significant difference between the performance levels of the two groups.

The results obtained from the application of statistical tests employed in the research do not support rejection of the null hypothesis. Therefore, the null hypothesis is accepted. Although the findings indicate no significant difference in the overall performance level of similarly placed impaired workers and their non-impaired co-workers, on inspection of individual behavioral variables, a significant difference in performance between the two groups was noticed on five of the forty-three items investigated.

Of these differences, the direction of the level of performance was favorable to the impaired worker on two of the five items and favorable to the non-impaired worker on the remaining three variables. The behavioral variables where differences existed, as well as the results of the aggregate performance scores of both groups, are explained below. No implication of the existence of casual factors is made; the findings reported reflect only the conditions as investigated.

Overall Level of Performance

Factor analysis

The principal components method of factor analysis was employed as a data reduction technique in the research. An unrotated factor investigation yielded one large halo factor as described by Michael Beer.[87] This factor accounts for rater perception of performance and is useful in developing an overall performance profile. A second rotated (varimax type) factor study uncovered a group of eight behavioral variables that accounted for thirty-five percent of the total variance. Both the rotated and unrotated factor inquiries served as a basis for further investigation with discriminate analysis techniques.

Aggregate sign test

To further investigate the data, a simple sign test

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[87]Michael Beer et al., "A Performance Management System: Research, Design, Introduction and Evaluation." Personnel Psychology 31 (1978): pg. 510.

was applied to each behavioral item. An overall sign test was applied to the results of the individual sign tests for comparison with the findings of the discriminant study. The two approaches, the discriminant technique and the application of the sign test to achieve an overall performance rating, were to point to the same conclusion--no difference exists between the performance of the impaired and non-impaired worker.

Discriminant analysis

The results of the factor investigations led to three discriminant studies. One path of the analysis included all the behavioral variables collected, with the exception of one due to size limitations of the biomedical computer programs used. The inclusion of all variables in the test for an overall performance evaluation was supported by the uncovering of the single halo factor with the aid of the factor analytic technique. No significant difference in the performance of the two groups was discovered through this approach. However, a relationship between rater leniency and rater strictness and the ability to discriminate between groups appeared.

The second discriminant investigation included the eight variables revealed in the varimax rotated factor analysis. Again, no significant difference in the performance of the two groups was noticed. This methodology led to the sense that on some one or some small number of behavioral variables, there might exist a significant difference in the

group means. However, as the number of questions (performance issues) increases, no significant differences between the means would exist. The explanation for this seems to be the fact that as supervisors begin looking at overall worker performance, they exhibit information processing simplification in accordance with the cognitive categorization theories discussed in chapter 2.

The third phase of the discriminant investigation focused on the five variables that showed a significant difference as a result of the sign test. Here, the discriminant and sign test technique were in agreement. The differences were significant on the performance ratings of the five behavioral variables. This confirmed earlier findings that on certain specific behavioral variables, differences exist between the performance of physically impaired and non-impaired co-workers.

Analysis of Specific Behavioral Variables

Since the sign test is applicable to the case of two related samples when the experimenter wishes to establish that two conditions are different, and since the data collected consisted of matched pairs of performance evaluations, it was chosen as the tool to initially investigate the specific behavioral items. On inspection of the forty-three behavioral variables, a significant performance difference between the two groups on five of the behavioral items was observed. These items were later included in a

more robust discriminant analysis where a similar difference in performance was established.

Variables favorable to the impaired worker

Of these differences, the direction of the level of performance was favorable to the impaired group of workers on two of the five behavioral items. These two variables were both from the openness to influence behavioral category and refer to the following specific situations:

1. The impaired worker more readily accepts suggestions or advice from others than does the non-impaired worker

2. The impaired worker does not avoid criticism by blaming others for his/her mistakes as readily as does the non-impaired worker

Variables favorable to non-impaired worker

The specific situations where significant differences between the two groups favored the non-impaired worker appeared from the constructive initiative and the decisiveness behavioral categories. More specifically, the results point out the following:

1. The non-impaired worker tends to take the initiative in group meetings over his/her impaired co-worker

2. The non-impaired worker more readily will take the initiative when others are hesitant

3. The non-impaired worker works better under

pressure than his/her impaired co-worker

Future Research

Behavioral categories

This exploratory research effort uncovered several possibilities for future research efforts. The behavioral categories of openness to influence, constructive initiative and decisiveness could be the focus of individual studies. These categories should be expanded to allow for a wider range of supervisory ratings. Perhaps the inclusion of industry specific behavioral items would yield a higher degree of worker performance information.

Expanding coverage

This survey was targeted to the employed graduates of some of the ARPDP's training and placement programs across the country. However, not all of the member programs of the ARPDP chose to participate. This research may have proven more benefical if all member groups had been included. Still, the move to a national survey of impaired and non-impaired co-workers across multiple work environments could provide a more general knowledge of the performance levels of the two groups of workers. In this case, proper identification of the industry and required work skill level parameters would be suggested.

Impaired worker reporting

The survey instrument used in this effort reflected some possible shortcomings that could be eliminated in fu-

ture efforts. One of these centers around the need to better identify the type(s) of physical impairments of the participating workers. A more clinical group of parameters may aid in this goal. The use of this information by the employers and educational institutions could enhance the mating of skill levels with the employers specific work environments. This information could also be used as the basis for additional training of employees in areas such as (1)assertiveness, (2)communications, (3) employee-employer networking, and (4) superior-subordinate relationships. Naturally, both impaired and non-impaired workers could benefit from such additional training.

The area of rater leniency and/or strictness should be of more concern in future research instruments in order to ensure that an accurate set of performance appraisals does not skew the statistical findings. Perhaps a method of screening the instruments with regard to supervisor type should be incorporated.

A longitudinal study that included such items as salary, title, and degree of responsibility progression within the firm or industry could increase the knowledge surrounding the area of performance of the physically impaired worker.

Synopsis

1. Findings of a discriminant analysis indicate that there is no significant difference in the overall

performance level of similarly placed impaired workers and their non-impaired co-workers

2. Application of both the sign test and a discriminant analysis to an overall performance rating agrees with the results of the aforementioned discriminant study

3. On inspections of individual behavioral items, the sign test uncovered significant differences between the two groups on five of the original forty-three items. A later discriminant study confirmed these differences

4. The impaired worker shows a stronger openness to influence behavioral trait than does the non-impaired worker

5. The non-impaired worker seems somewhat stronger in the behavioral categories of constructive initiative and decisiveness than the impaired co-worker

This exploratory research has contributed to the area of impaired and non-impaired co-worker performance, and has provided a foundation for future research endeavors. It is hoped that the additional information provided from this and ensuing efforts will lead toward a rise in the overall performance level of all workers.

UNIVERSITY OF MISSOURI-COLUMBIA

College of Business and Public Administration

Minuteman Graduate Program in Business
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APPENDIX 1

Date

Name
Title
Street Address
City, State Zipcode

Much evidence exists that illustrates the ability of the handicapped individual. The current literature has focused on the areas of the workers' attendance, attitude and job stability. However, no one really knows what kind of performance is available from a group of physically impaired workers that are fully able to compete successfully in an environment containing nonimpaired co-workers.

You are one of a small number of individuals which are being asked to aid in the gathering of knowledge about worker performance. Your hard work, and training with an affiliate of the Association of Rebabilitation Programs in Data Processing (ARPDP) has awarded you a unique place within the Data Processing Industry. In order to best assemble the information necessary, questions should be directed to your supervisor or employer. However, it is my, and the ARPDP's feeling that you should be contacted before any questions be directed toward your employer. It is important that you only, and not a co-worker or other individual, participate in this study by supplying the requested information on the enclosed sheet. Your participation will enable me to send a short series of questions to your employer requesting responses concerning physically impaired and nonimpaired worker performance.

You may be assured of complete confidentiality. The questionnaire has an identification number for mailing purposes only. This is so that I may check your employers name off the mailing list when their questionnaire is returned. Your name will never be placed on the questionnaire.

The results of this research will be made avaliable to officials and members of the ARPDP as well as to those employers that are interested. You may receive a summary of the results by simply circling "Yes" as the answer to the question "Copy of the resluts requested?" that appears on the enclosed sheet. This study offers the chance to

participate in the gathering of useful information to confirm the declaration that physically handicapped individuals do make equally competitive employees.

I would be most happy to answer any questions you might have. Please write or call. My home telephone number is (816) 563-2129.

Thank you for your assistance.

Sincerely,

Van D. Gray
Instructor

INSTRUCTIONS:

Pleae fill in the appropriate response in the space provided, then return this sheet in the stamped, pre-addressed envelope provided.

Q-1 The questionnaire regarding worker performance should be directed to the following person:

NAME _____
TITLE _____
ADDRESS _____
_____
CITY _____
STATE _____
ZIPCODE _____

Q-2 Copy of the results requested? (Circle your answer)

1. Yes
2. No

Q-3 Is your address below correct? If not, please make corrections.

Name
Title
Company Name
Street Address
City, State Zipcode

Thanks again for your help with this important study.

Follow-Up Postcard

Second Mail-out

Several weeks ago, a letter seeking your cooperation in a study of the performance of physically impaired workers was mailed to you. Your name was chosen because of your affiliation with the Association of Rehabilitation Programs in Data Processing.

If you have already completed and returned the requested information, please accept my sincere thanks. If not, please do so today. Because this study involves a small, unique group, your participation is extremely important for accurate results.

If by some chance you did not receive the letter and three-question enclosure, or it was misplaced, please contact me right now, collect (816) 563-2129, and I will get another one in the mail to you today.

Second Follow-Up Letter

Third Mail-out

Date

Name
Title
Company Address
City, State Zipcode

About three weeks ago I wrote to you seeking your participation in a survey of worker performance. As of today I have not yet received your completed questionnaire.

This research effort was undertaken because of the belief that adequate knowledge regarding the performance of physically impaired workers and their non-impaired co-workers was important for the planning and development of a most important labor resource.

I am writing to you again because of the significance each questionnaire has to the usefulness of this study. Your name was chosen on account of your training through one of the member programs of the ARPDP. Since these programs are unique, only 179 individuals are being invited to complete this questionnaire. In order for the results of this study to be truly representative, it is essential that each person return their questionnaire. As mentioned in my last letter, the questionnaire should be completed by an employed graduate of an ARPDP program. If you are currently unemployed indicate so on the questionnaire materials and return them. If you are merely between jobs, perhaps your previous supervisor would be willing to participate in this study.

In the event that your questionnaire has been misplaced, a replacement is enclosed. Again, thank-you. Your cooperation is greatly appreciated.

Sincerely,

Van D. Gray
Instructor

APPENDIX 2

QUESTIONNAIRE

SURVEY OF WORKER PERFORMANCE

Directions:

There are two identical questionnaires. One is to be answered while considering the behavior of a physically impaired worker under your supervision. The remaining survey is to be answered while considering the behavior of a non-impaired co-worker of the previously selected physically impaired worker.

Please respond to all questions. Place a check mark in the box that corresponds to your answer.

This survey is composed of 11 categories containing a total of 43 questions. There are several additional questions of special interest to this study at the end of the form. Immediately after each category header is a short descriptive statement. This statement is designed to aid in setting the climate necessary to answer the questions in that category. To correctly complete the questionnaire, read the behavioral climate statement accompanying each category, then rate the worker by indicating the extent (agree - disagree) to which you (the supervisor) believe that the statement reflects the subordinates' (the impaired or non-impaired workers) behavior.

Definitions of Terms:

Physically Impaired Worker. For the purpose of this study, a physically impaired worker is a professional employee who has a physical impairment (walking, seeing, hearing, or speaking) which substantially limits his or her ability to work; this person is also a graduate of one of the member institutions of the Association of Rehabilition Programs in Data Processing (ARPDP).

Non-Impaired Co-Worker. A non-impaired co-worker is a professional employee who is engaged in a similar set of job duties in the same data processing enviornment with one or more of the physically impaired workers described above.

SURVEY OF WORKER PERFORMANCE

* *

IMPORTANT - Answer this question first (circle either A or B).

This survey reflects the behavior of a A. PHYSICALLY IMPAIRED / B. NON-IMPAIRED employee under my supervision.

* *

1. **COLLABORATION** - Extends his efforts beyond his immediate job requirements both within and outside his own job.

		Insufficient Information	Strongly Agree	Somewhat Agree	Undecided	Somewhat Disagree	Strongly Disagree	Not Relevant
Q-1	Offers constructive ideas both within and outside his own job	☐	☐	☐	☐	☐	☐	☐
Q-2	Provides assistance and guidance to others	☐	☐	☐	☐	☐	☐	☐
Q-3	Goes beyond the bare requirements of his job when working on assigned tasks. .	☐	☐	☐	☐	☐	☐	☐

II. **CREDIBILITY** - People react favorably toward him and have confidence in him.

Q-4	Behaves in a way which causes people to react favorably towards him . . .	☐	☐	☐	☐	☐	☐	☐
Q-5	Has the confidence of his superiors	☐	☐	☐	☐	☐	☐	☐
Q-6	Has the confidence of his peers	☐	☐	☐	☐	☐	☐	☐

III. **OPENNESS TO INFLUENCE** - Willing to consider ideas and new methods and accept criticism, suggestions or advice from others.

		Insufficient Information	Strongly Agree	Somewhat Agree	Undecided	Somewhat Disagree	Strongly Disagree	Not Relevant
Q-7	Objects to ideas before they are explained	☐	☐	☐	☐	☐	☐	☐
Q-8	Refuses to accept suggestions or advice from others	☐	☐	☐	☐	☐	☐	☐
Q-9	Tries to avoid criticism by blaming others for his mistakes	☐	☐	☐	☐	☐	☐	☐
Q-10	Tends to approach things in his own way while outwardly agreeing to new methods . .	☐	☐	☐	☐	☐	☐	☐

IV. **CONSTRUCTIVE INITIATIVE** - Takes the initiative in acquiring and sharing constructive ideas through involvement with conviction.

Q-11	Takes the initiative in group meetings	☐	☐	☐	☐	☐	☐	☐
Q-12	Offers constructive ideas to others outside his own organizational unit	☐	☐	☐	☐	☐	☐	☐
Q-13	Attempts to expand technical or administrative knowledge in areas where he is not fully competent	☐	☐	☐	☐	☐	☐	☐
Q-14	Communicates his ideas with conviction	☐	☐	☐	☐	☐	☐	☐

V. **PRIORITY SETTING** - Considers alternatives and is able to establish priorities and distinquish between the important and unimportant.

		Insufficient Information	Strongly Agree	Somewhat Agree	Undecided	Somewhat Disagree	Strongly Disagree	Not Relevant
Q-15	Is able to distinquish between important and unimportant problems	☐	☐	☐	☐	☐	☐	☐
Q-16	Consciously establishes priorities in his work . . .	☐	☐	☐	☐	☐	☐	☐
Q-17	Establishes priorities and takes action on the basis of the importance of the problem	☐	☐	☐	☐	☐	☐	☐
Q-18	Considers available alternatives of action before arriving at a final decision .	☐	☐	☐	☐	☐	☐	☐

VI. **FORMAL COMMUNICATIONS** - Speaks clearly and interestingly before groups and prepares complete reports.

Q-19	Gives poor presentations . .	☐	☐	☐	☐	☐	☐	☐
Q-20	Uses a steady, dull monotone in his speech	☐	☐	☐	☐	☐	☐	☐
Q-21	Speaks clearly and concisely before groups	☐	☐	☐	☐	☐	☐	☐
Q-22	Prepares incomplete reports.	☐	☐	☐	☐	☐	☐	☐

VII. **ORGANIZATIONAL PERSPECTIVE** - Considers the total organization when making decisions and involves people from other departments in his work.

		Insufficient Information	Strongly Agree	Somewhat Agree	Undecided	Somewhat Disagree	Strongly Disagree	Not Relevant
Q-23	Sees his problems in light of the problems of others (i.e., does not limit his thinking to his own position or organizational unit) . .	☐	☐	☐	☐	☐	☐	☐
Q-24	Gets people outside his own department to work with him.	☐	☐	☐	☐	☐	☐	☐
Q-25	In making decisions in his own organizational unit, he keeps the objectives of the larger organization in mind.	☐	☐	☐	☐	☐	☐	☐
Q-26	Fails to communicate across department lines	☐	☐	☐	☐	☐	☐	☐

VIII. **FLEXIBILITY** - Is flexible and will attempt new methods and keeps up with current developments in his field.

Q-27	Will attempt new methods and not be limited by old ways of doing things	☐	☐	☐	☐	☐	☐	☐
Q-28	Adapts readily to new situations	☐	☐	☐	☐	☐	☐	☐
Q-29	Does not keep up with current developments in his field	☐	☐	☐	☐	☐	☐	☐
Q-30	Is enthusiastic in carrying out new work assignments . .	☐	☐	☐	☐	☐	☐	☐

IX. **THOROUGHNESS AND ACCURACY** - Is thorough, accurate, and logical in his work.

		Insufficient Information	Strongly Agree	Somewhat Agree	Undecided	Somewhat Disagree	Strongly Disagree	Not Relevant
Q-31	Gives sufficient attention to detail when seeking problem solutions	☐	☐	☐	☐	☐	☐	☐
Q-32	Is accurate in his work . .	☐	☐	☐	☐	☐	☐	☐
Q-33	Uses a scientific approach to problem solution (i.e., observe, analyze, evaluate, decide, implement, follow-up)	☐	☐	☐	☐	☐	☐	☐
Q-34	Is not thorough in approach to work assignments	☐	☐	☐	☐	☐	☐	☐
Q-35	Makes unwarranted or illogical assumptions in solving problems	☐	☐	☐	☐	☐	☐	☐

X. **WORK ACCOMPLISHMENT** - Is able to meet deadlines and doesn't have to be pushed to get the job finished.

Q-36	Has difficulty in meeting project deadlines	☐	☐	☐	☐	☐	☐	☐
Q-37	Needs to be "pushed" to get job finished	☐	☐	☐	☐	☐	☐	☐
Q-38	Performs a large amount of work in the time available .	☐	☐	☐	☐	☐	☐	☐

XI. DECISIVENESS - Takes initiative in decision making and problem solving and works well under pressure.

		Insufficient Information	Strongly Agree	Somewhat Agree	Undecided	Somewhat Disagree	Strongly Disagree	Not Relevant
Q-39	Will take initiative when others are hesitant to . . .	☐	☐	☐	☐	☐	☐	☐
Q-40	Hesitates to make decisions.	☐	☐	☐	☐	☐	☐	☐
Q-41	Will act on his own initiative when confronted with a problem	☐	☐	☐	☐	☐	☐	☐
Q-42	Works well under pressure. .	☐	☐	☐	☐	☐	☐	☐
Q-43	Uses good judgement in difficult situations	☐	☐	☐	☐	☐	☐	☐

* *

XII. Please indicate the size and characteristics of your DP installation (add additional comments if necessary).

Q-44 Number of employees in your company (world-wide).

____

Q-45 Number of employees in the data processing section.

____

Q-46 Total number of employees at your facility.

____

Q-47 Typical annual expenditures on DP equipment.

_____

Q-48 Type of equipment used (IBM, DEC, etc.).

_____

Q-49 Primary work area (ex., manufacturing control, accounting, education, defense, etc.).

_____

Q-50 Additional comments regarding your DP installation?

_____

_____

_____

* *

THE NEXT TWO QUESTIONS NEED BE ANSWERED
ONLY ON THE SURVEY DEALING WITH THE
PHYSICALLY-IMPAIRED WORKER

* *

Q-51 Is the impaired worker being evaluated a graduate of a member program of the Association of Rehabilitation Programs in Data Processing (ARPDP).

(circle one)

1 YES

2 NO

****** THIS QUESTION IS OPTIONAL ******

Q-52 Classify the impairment of the physically handicapped employee.

(choose one, or if the correct classification is missing, add to the list in the space provided.)

1 WALKING

2 SEEING

3 SPEAKING

4 HEARING

5 OTHER (explain) _____

* *

Is there anything else you would like to tell us about the performance of the worker you have been evaluating? If so, please use this space for that purpose.

Also, any comments you wish to make that you think may help us in the future to understand worker performance in the data processing industry will be appreciated, either here or in a separate letter.

_____

Your contribution to this effort is very greatly appreciated. If you would like a summary of results, please print your name and address on the back of the return envelope. I will see that you receive it.

NO._____

APPENDIX 3

UNROTATED FACTOR LOADINGS
FOR PRINCIPAL COMPONENTS ANALYSIS

Question number	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5
Q-1	0.792	0.272	0.188	0.268	-0.007
Q-2	0.682	0.387	0.186	0.122	-0.202
Q-3	0.680	0.425	0.078	0.045	-0.271
Q-4	0.590	-0.282	-0.206	0.350	0.083
Q-5	0.769	0.259	-0.264	0.189	0.009
Q-6	0.700	0.272	-0.198	0.134	0.094
Q-7	-0.358	0.648	0.327	-0.059	-0.223
Q-8	-0.400	0.479	0.488	-0.069	-0.075
Q-9	-0.266	0.503	0.447	0.071	-0.160
Q-10	-0.582	0.311	0.494	-0.177	-0.081
Q-11	0.575	-0.137	0.499	-0.027	0.310
Q-12	0.505	-0.018	0.349	-0.033	0.224
Q-13	0.549	0.325	-0.151	0.354	0.284
Q-14	0.598	0.061	0.197	0.293	0.352
Q-16	0.592	0.229	0.067	-0.489	0.269
Q-18	0.610	0.471	-0.127	0.045	-0.138
Q-19	-0.518	0.286	-0.271	-0.326	0.290
Q-20	-0.288	0.307	-0.488	-0.326	0.419
Q-21	0.530	-0.415	0.388	0.107	-0.458
Q-22	-0.519	0.141	0.188	0.199	0.232
Q-24	0.775	-0.239	0.053	0.160	-0.111
Q-25	0.456	-0.317	0.222	-0.238	0.002
Q-26	-0.631	0.508	-0.101	0.070	0.258
Q-27	0.640	0.102	-0.443	0.352	0.056
Q-28	0.673	-0.117	-0.424	-0.011	-0.059
Q-29	-0.718	-0.170	-0.015	0.051	0.109
Q-30	0.568	0.169	-0.314	0.340	-0.164
Q-32	0.711	0.165	-0.210	-0.315	-0.108
Q-33	0.605	0.295	0.096	-0.238	-0.122
Q-34	-0.585	0.129	-0.021	0.583	0.080
Q-35	-0.599	0.051	0.301	0.542	0.001
Q-36	-0.638	-0.154	0.093	0.463	-0.135
Q-38	0.707	0.290	0.095	-0.064	-0.077
Q-39	0.621	-0.017	0.559	-0.040	0.319
Q-40	-0.456	0.446	-0.466	0.029	-0.259
Q-41	0.572	-0.022	0.310	0.161	0.497
Q-42	0.546	-0.171	0.019	-0.405	-0.187

Questions fifteen, seventeen, twenty-three, thirty-one, thirty-seven, and forty-three were excluded from the study.

UNROTATED SORTED FACTOR LOADINGS
FOR PRINCIPAL COMPONENTS ANALYSIS

Question number	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5
Q-1	0.792	0.272	0.188	0.268	-0.007
Q-24	0.775	-0.239	0.053	0.160	-0.111
Q-5	0.769	0.259	-0.264	0.189	0.009
Q-29	-0.718	-0.170	-0.015	0.051	0.109
Q-32	0.711	0.165	-0.210	-0.315	-0.108
Q-38	0.707	0.290	0.095	-0.064	-0.077
Q-6	0.700	0.272	-0.198	0.134	0.094
Q-2	0.682	0.387	0.186	0.122	-0.202
Q-3	0.680	0.425	0.078	0.045	-0.271
Q-28	0.673	-0.117	-0.424	-0.011	-0.059
Q-27	0.640	0.102	-0.443	0.352	0.056
Q-36	-0.638	-0.154	0.093	0.463	-0.135
Q-26	-0.631	0.508	-0.101	0.070	0.258
Q-39	0.621	-0.017	0.559	-0.040	0.319
Q-18	0.610	0.471	-0.127	0.045	-0.138
Q-33	0.605	0.295	0.096	-0.238	-0.122
Q-35	-0.599	0.051	0.301	0.542	0.001
Q-14	0.598	0.061	0.197	0.293	0.352
Q-16	0.592	0.229	0.067	-0.489	0.269
Q-4	0.590	-0.282	-0.206	0.350	0.083
Q-34	-0.585	0.129	-0.021	0.583	0.080
Q-10	-0.582	0.311	0.494	-0.177	-0.081
Q-11	0.575	-0.137	0.499	-0.027	0.310
Q-41	0.572	-0.022	0.310	0.161	0.497
Q-30	0.568	0.169	-0.314	0.340	-0.164
Q-13	0.549	0.325	-0.151	0.354	0.284
Q-42	0.546	-0.171	0.019	-0.405	-0.187
Q-21	0.530	-0.415	0.388	0.107	-0.458
Q-19	-0.518	0.286	-0.271	-0.326	0.290
Q-12	0.505	-0.018	0.349	-0.033	0.224
Q-7	-0.358	0.648	0.327	-0.059	-0.223
Q-9	-0.266	0.503	0.447	0.071	-0.160
Q-22	-0.519	0.141	0.188	0.199	0.232
Q-20	-0.288	0.307	-0.488	-0.326	0.419
Q-40	-0.456	0.446	-0.466	0.029	-0.259
Q-8	-0.400	0.479	0.488	-0.069	-0.075
Q-25	0.456	-0.317	0.222	-0.238	0.002

Questions fifteen, seventeen, twenty-three, thirty-one, thirty-seven, and forty-three were excluded from the study.

ROTATED FACTOR LOADINGS
FOR PRINCIPAL COMPONENTS ANALYSIS
(VARIMAX ROTATION)

Question number	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5
Q-1	0.635	0.380	-0.178	0.373	0.099
Q-2	0.743	0.202	-0.075	0.223	0.148
Q-3	0.831	0.066	-0.148	0.141	0.104
Q-4	0.264	0.152	-0.042	0.390	-0.372
Q-5	0.714	0.133	-0.187	0.358	-0.244
Q-6	0.777	0.172	-0.132	0.171	-0.259
Q-7	0.128	-0.178	0.166	-0.080	0.798
Q-8	-0.059	-0.002	0.030	-0.242	0.799
Q-9	-0.027	0.003	0.035	0.008	0.795
Q-10	-0.206	-0.074	0.173	-0.379	0.726
Q-11	0.173	0.729	-0.217	0.009	-0.039
Q-12	0.322	0.475	-0.205	-0.006	-0.003
Q-13	0.488	0.325	-0.172	0.350	-0.131
Q-14	0.140	0.630	-0.027	0.610	0.046
Q-16	0.336	0.375	-0.659	0.031	0.011
Q-18	0.748	0.090	-0.162	0.190	-0.108
Q-19	-0.243	-0.191	0.111	-0.053	0.125
Q-20	-0.049	-0.206	-0.170	-0.051	-0.014
Q-21	0.091	0.189	-0.079	0.134	-0.090
Q-22	-0.189	0.038	0.686	-0.001	0.244
Q-24	0.260	0.254	-0.184	0.544	-0.165
Q-25	0.082	0.282	-0.177	0.055	-0.153
Q-26	-0.178	-0.130	0.192	-0.123	0.360
Q-27	0.346	0.063	-0.097	0.797	-0.294
Q-28	0.158	-0.014	-0.352	0.745	-0.316
Q-29	-0.489	-0.219	0.349	-0.335	0.121
Q-30	0.424	-0.055	-0.011	0.684	-0.139
Q-32	0.598	0.057	-0.513	0.031	-0.277
Q-33	0.445	0.250	-0.274	0.206	0.037
Q-34	-0.055	-0.128	0.818	-0.154	0.082
Q-35	-0.278	0.003	0.676	-0.093	0.315
Q-36	-0.192	-0.248	0.753	-0.278	0.004
Q-38	0.563	0.243	-0.337	0.209	0.120
Q-39	0.211	0.825	-0.161	0.069	0.048
Q-40	0.170	-0.702	0.174	-0.033	0.155
Q-41	0.361	0.781	0.059	0.018	-0.241
Q-42	0.182	0.142	-0.308	0.047	-0.200

Questions fifteen, seventeen, twenty-three, thirty-one, thirty-seven, and forty-three were excluded from the study.

SORTED ROTATED FACTOR LOADINGS
FOR PRINCIPAL COMPONENTS ANALYSIS
(VARIMAX ROTATION)

Question number	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5
Q-3	0.831				
Q-6	0.777				
Q-18	0.748				
Q-2	0.743				
Q-5	0.714				
Q-1	0.635				
Q-32	0.598				
Q-38	0.563				
Q-39		0.825			
Q-41		0.781			
Q-11		0.729			
Q-40		-0.702			
Q-14		0.630			
Q-34			0.818		
Q-36			0.753		
Q-22			0.686		
Q-35			0.676		
Q-16			-0.659		
Q-27				0.797	
Q-28				0.745	
Q-30				0.684	
Q-24				0.544	
Q-8					0.799
Q-7					0.798
Q-9					0.795
Q-10					0.726

Questions fifteen, seventeen, twenty-three, thirty-one, thirty-seven, and forty-three were excluded from the study.

APPENDIX 4

```
1       REM ************************************************
2       REM **                                            **
3       REM **  Program to calculate the probability      **
4       REM **  associated with the occurrence of a       **
5       REM **  particular number of +'s and -'s by ref-  **
6       REM **  erence to the Binomial distribution with  **
7       REM **  P = Q = .5, where N = The number of       **
8       REM **  matched pairs who showed differences and  **
9       REM **  X = the number of fewer signs.            **
10      REM **                                            **
11      REM **                                            **
12      REM **  Date Written : December 15, 1983          **
13      REM **  Author : Van Dyke Gray                    **
14      REM **  Language/Version : Microsoft Basic        **
15      REM **                     version 5.03           **
16      REM **                                            **
17      REM ************************************************
100   DEFDBL A-Z
110   DEFINT X,N,H,L
120   INPUT "      Please enter the case or question number
      (or QUIT) ==> ",ANS$
130   IF LEFT$(ANS$,1)="Q" OR LEFT$(ANS$,1)="q" THEN GOTO 460
140   INPUT "Please enter the value for N (total number) ==>
      ",N
150   PRINT
160   PRINT
170   INPUT "      And the value for X (observed number) ==>
      ",X1
180   FOR X=0 TO X1
190      HL=(N-X) : LL=X
200      Y=1
210      FOR I%=HL+1 TO N
220               Y=Y*I%
230      NEXT
240      Z=1
250      FOR J%=1 TO LL
260               Z=Z*J%
270      NEXT
280      ANS=ANS+Y/Z
290   NEXT
300   BP=ANS*(.5)^N
310   PRINT : PRINT
320   PRINT " One-Tailed Probability is =====> ";BP
330   PRINT " Two-Tailed Probability is =====> ";BP * 2
340   PRINT : PRINT : INPUT "    Would you like a printed
```

```
    output ? (y/n) ==> ";O$
350 O$=LEFT$(O$,1)
360 IF O$<>"Y" AND O$<>"y" THEN GOTO 120
370 PRINT : PRINT : INPUT "   Please TURN ON your PRINTER,
    then press RETURN ",RT$
380 LPRINT STRING$(35,"-")
390 LPRINT : LPRINT "     Question # ";ANS$
400 LPRINT : LPRINT "                N equals ==> ";N
410 LPRINT : LPRINT "                X equals ==> ";Xl
420 LPRINT  :  LPRINT  "     The Two-Tailed Probability  is
    =====> ";BP
430 LPRINT : LPRINT "     The One-Tailed Probability is
    =====> ";BP * 2
440 LPRINT STRING$(35,"-")
450 GOTO 120
460 END
```

SIGN TEST EXAMPLE

Question #1 -- Offers constructive ideas both within and outside his own job

Case #	Rating X_a	Rating X_b	Sign	Case #	Rating X_a	Rating X_b	Sign
1	5	5		26	5	3	+
2	5	4	+	27	3	3	
3	3	5	-	28	2	4	-
4	3	3		29	2	2	
5	2	2		30	5	2	+
6	2	2		31	6	3	+
7	3	3		32	3	3	
8	2	2		33	5	3	+
9	2	3	-	34	3	3	
10	2	3	-	35	2	3	-
11	4	2	+	36	2	3	-
12	3	3		37	3	3	
13	2	3	-	38	3	2	+
14	2	2		39	3	2	+
15	3	3		40	1	1	*
16	2	2		41	2	3	-
17	3	5	-	42	3	5	-
18	3	2	+	43	2	2	
19	3	3		44	3	4	-
20	4	4		45	2	2	
21	3	5	-	46	3	3	
22	4	3	+	47	2	2	
23	2	2		48	3	5	-
24	3	3		49	3	3	
25	3	2	+	50	2	3	-

X_a = Impaired
X_b = Nonimpaired

(+) $X_a > X_b$ = 11
(-) $X_a < X_b$ = 14
( ) $X_a = X_b$ = 24
(*) out of limits, therefore not used
N Sample size for sign test = 25 = (11 + 14)

alpha = 0.05
one-tailed probability = .345

H_0 is accepted

BIBLIOGRAPHY

General

Books

Baker, Sheridan. The Practical Stylist. 2nd ed. New York: Thomas Y. Crowell Company, 1969.

Backstrom, Charles H., and Hursch, Gerald D. Survey Research. Edited by James A. Robinson. Forward by the editor. Handbooks for Research in Political Behavior Series. Chicago: Northwestern University Press, 1963.

Bellamy, G. T.; Horner, R. H.; and Inman, D. P. Vocational Habilitation of Severely Retarded Adults. Baltimore: University Park Press, 1979.

Bieri, J. Clinical and Social Judgment. New York: John Wiley, 1966.

Bowe, Frank. Handicapping America: Barriers to Disabled People. New York: John Wiley and Sons, 1978.

Brolin, D. E. Vocational Preparation of Retarded Citizens. Columbus, Ohio: Charles E. Merrill, 1979.

Clover, Vernon T. and Balsley, Howard L. Business Research Methods. 2nd ed. Columbus, Ohio: Grid Publishing, 1979.

Dillman, Don A. Mail and Telephone Surveys: The Total Design Method. New York: John Wiley and Sons, 1978.

Erdos, Paul L. Professional Mail Surveys. New York: McGraw-Hill, 1970.

Goldenson, Robert M. (ed.). Disability and Rehabilitation Handbook. New York: McGraw-Hill, 1978.

Hodges, John C., and Whitten, Mary E. Harbrace College Handbook. 9th ed. New York: Harcourt Brace Jovanovich, 1982.

Katz, William A. Introduction to Reference Work. 3rd ed. Vol 1. New York: McGraw-Hill, 1978.

Kessler, Henry H. Rehabilitation of the Physically Handicapped. New York: Columbia University Press, 1953.

Kerlinger, Fred N. Foundations of Behavioral Research. New York: Holt, Rhinehart, and Winston, 1965.

Leedy, Paul D. Practical Research: Planning and Design. New York: Macmillan Publishing Company, Inc., 1974.

Lindzey, Gardner, and Aronson, Elliot (Eds.). The Handbook of Social Psychology. Vol 2. Reading, Massachusetts: Addison-Wesley, 1968.

The McGraw-Hill Author's Book. with an Introduction by Edward E. Booher. New York: McGraw-Hill, 1968.

Mendenhall, William; Ott, Lyman; and Scheaffer, Richard L. Elementary Survey Sampling. Belmont, California: Duxbury Press, 1971.

Minnesota Studies in Vocational Rehabilitation. Attitudinal Barriers to Employment. University of Minnesota, Industrial Rehabilitation Center, June, 1961.

Mobler, W. R. Twenty Years of Merit Rating: 1926-1947. New York: The Psychological Corporation, 1947.

Northrup, James P. Old Age, Handicapped and Vietnam-Era Antidiscrimination Legislation. Pennsylvania: Trustees of the University of Pennsylvania, 1977.

Parten, M. Surveys, Polls and Samples. New York: Harper and Row, 1950.

Plato. Republic. Book V. Translated by B. Jowett. New York: Random House, 1941.

Publication Manual of the American Psychological Association. with a forward by Arthur W. Melton. 2nd ed. Baltimore, Maryland: Garamond/Pridemark Press, Inc., 1981.

Rusch, F. R., and Mithaug, D. E. Vocational Training for Mentally Retarded Adults. Champaign, Illinois: Research Press, 1979.

Rusk, Howard A.; Taylor, M. D.; and Taylor, Eugene J. New Hope for the Handicapped. New York: Harper and Brothers, 1949.

Sellitz, Claire; Jahoda, Marie; Deutsch, Morton; and Cook, Stuart W. Research Methods in Social Relations. Chicago: Holt, Rinehart and Winston, 1959.

Strunk, William, Jr. The Elements of Style. 3rd ed., with Revisions, an Introduction, and a Chapter by E. B. White. New York: Macmillan, 1979.

Turabian, Kate L. A Manual for Writers of Term Papers, Theses, and Dissertations. 4th ed. Chicago: The University of Chicago Press, 1973.

Veldman, D. Fortran Programming for the Behavioral Sciences. New York: Holt, Rinehart and Winston, 1967.

Periodicals

Alpert, M. I. and Peterson, R. A. "On the Interpretation of Canonical Analysis." Journal of Marketing Research. Vol 9., 1972.

Arbeit, Stanley. "Cripple Bias and the TD." Training in Business and Industry. (November 1973): 35-37.

Beer, Michael and Rich, Robert A. "Employees Growth Through Performance Management." Harvard Business Review, July 1976.

Beer, Michael; Ruth, Robert; Dawson, Jack A.; McCaa, B. B.; and Kavanaugh, Michael J. "A Performance Management System: Research, Design, Introduction and Evaluation." Personnel Psychology, Vol. 31, 1978.

Bressler, Ray B., and Lacy, A. Wayne. "An Analysis of the Relative Job Progression of the Perceptibly Physically Handicapped." Academy of Management Journal. Vol 23. no. 1, 1980.

Colbert, J.; Kalisk, R.; and Chang, P. "Two Psychological Portals of Entry for Disadvantaged Groups." Re-Habilitation Literature, July 1973, pp. 194-202.

Cooper, N. E. "Vocational Reintegration of Handicapped Workers with Assistive Devices." International Labour Review. 115(3) (May-June 1977): 343-352.

Cornelius, Edwin T., III; Hakel, Milton D.; and Sackett, Paul R. "A Methodological Approach to Job Classification for Performance Appraisal Purposes." Personnel Psychology. Summer 1979. pp. 283-297.

Clutterbuck, David. "Routine Work Can Present a Challenge." International Management. (July 1975): 39-40.

_____. "Helping the Disabled Pay Their Way." International Management. (June 1975): 34-42.

Decker, Louis R., and Peed, Daniel A. "Affirmative Action for the Handicapped." Personnel. (May-June 1976): 64-69.

"Firms Get Their Money's Worth By Hiring Disabled Employees." Commerce Today, 29 September 1975, pp. 8-9.

Flamholtz, Eric. "The Convergent and Discriminant Validity of the Stochastic Rewards Model for Human resource Valuation: A Field Study." Personnel Review. Summer 1980. pp. 39-50.

Flanigan, J. C. "A New Approach to Evaluating Personnel." Personnel, 26, 1949.

"Firms Get Their Money's Worth by Hiring Disabled Employees." Commerce Today. 29 September 1975, vol 5, no. 26. pg. 8-9.

"Fitting the Job to the Handicapped Worker." Journal of American Insurance. Winter 1976-77, vol 52, no. 4. pg. 23-27.

Franklin, Paula A., and Hennessey, John C. "Effect of Substantial Gainful Activity Level on Disabled Beneficiary Work Patterns." Social Security Bulletin. 42 (3) (March 1979): 3-12.

Glenn, Gary O.; Chavez, Vincente C.; Milne, Dann; and Peters, Carl C. "Order Out of Confusion." Journal of Systems Management. January 1981. pp. 18-25.

Guy, Jana H. "The Rehabilitation Act of 1973--Its Impact on Employee Selection Practices." Employee Relations Law Journal. (Summer 1978): 2-23.

Hammond, Norman C. "New DP Consciousness: Considering the Handicapped." Data Management. October 1978. pp. 31-36.

Hoffman, Randal R. "MJS: Management by Job Standards." Personnel Journal, August 1979, pp. 536-540+.

Huddle, D. "Work Performance of Trainable Adults and Influenced by Competition, Cooperation and Monetary Reward." American Journal on Mental Deficiency, 1967, Vol. 72, pp. 198-211.

Hunter, Patricia N. and Zuger, Rosalind R. "Coming Face to Face With Rehabilitation." Personnel Journal. (January 1979): 41-42.

Jackson, Diane P. "Update on Handicapped Discrimination."

Personnel Journal. (September 1978): 488-491.

Jerome, Peter M. "Handicapped Individuals in the Changing Workforce." Journal of Contemporary Business, Vol. 8, No. 4, 1979, pp. 33-42.

Journal of American Insurance. "Workers Worth Their Hire." Summer 1975. pp. 29-32.

Kansas City Star, 6 November 1979; 18 February 1984.

Kapur, R., and Liles, D. H. "Job Design for Persons With Physical Disablities." AIIE Proceedings, 1982 Conference. (23-27 May 1982): 169-178.

Kearney, William J. "Behaviorally Anchored Rating Scales--MBO's Missing Ingredient." Personnel Journal. (January 1979): 20-25.

Kettle, Melvyn, and Massie, Bert. "Need a Disability Be a Handicap?" Personnel Management. February 1981. pp. 32-35.

Longmate, A. R.and Armstrong, T. J. "Employment of Physically Limited Persons." AIIE Proceedings, 1982 Conference. (23-27 May 1982): 188-193.

Malzahn, D. "Job Modification and Placement Strategies for Persons with Physical Disablities Using the Available Motions Inventory." AIIE Proceedings, 1982 Conference. (23-27 May 1982): 179-187.

McGregor, D. "An Uneasy Look at Performance Appraisal." Harvard Business Review, Vol. 43, 1965.

Milk, Leslie B. "Who is Qualified? Who is Handicapped? What is Reasonable?: The Key to Job Accommodation." The Personnel Administrator. (January 1979): 31-38.

Miller, Joyce D. "New Focus on the Handicapped." American Federationist, (January 1978): 17-20.

Mithaug, Dennis E. "The Changing Workforce: An Introduction." Journal of Contemporary Business, Vol. 8, No. 4, 1979, pp. 1-4.

Nathanson, Robert B. "The Disabled Employee--Separating Myth From Fact." Harvard Business Review. (May-June 1977): 6-8.

Pati, Gopal C. "Countdown on Hiring the Handicapped." Personnel Journal. (March 1978): 144-153.

Peters, Lawrence H.; O'Connor, Edward J.; and Rudolf, Cathy

J. "The Behavioral and Affective Consequences of Performance--Relevant Situational Variables." Organizational Behavior and Human Performance. 25 (1980): 79-96.

Rose, Gerald L., and Brief, Arthur P. "Effects of Handicap and Job Characteristics on Selection Evaluations." Personnel Psychology. 32 (1979): 385-392.

Rusch, F. R.; Schultz, P.; Lamson, D. S.; and Menchetti, B. M. "Vocational Training and Employment Program: Interim Report." University of Illinois, Department of Special Education, College of Education, 1979.

Sauser, William I. "Evaluating Employee Performance: Needs, Problems and Possible Solutions." Public Personnel Management, Vol. 9. no. 11, January 1980.

Schick, Melvin E. "The 'Refined' Performance Evaluation Monitoring System: Best of Both Worlds." Personnel Journal, January 1980.

Sheibar, Paul. "A Simple Selection System Called 'Jobmatch'." Personnel Journal. (January 1979): 26-29.

Smith, P. C. "Behaviors, Results, and Organizational Effectiveness: The Problem of Criteria." In Handbook of Industrial and Organizational Psychology, p. 753. Edited by M. D. Dunnette. Chicago: Rand-McNally, 1976.

Steinhauser, Larry and Vieceli, Louis. "Affirmative Action for the Handicapped." Supervisory Management. October 1978.

Strom, Linda J., and Ferris, Gerald R. "Issues in Hiring the Handicapped: A Positive Outlook." Personnel Administrator. August 1982.

"Suit Seeks Equal Education for Handicapped". The Kansas City Star, 6 February 1980, sec 3A, p 1.

"The Perils in Not Hiring the Handicapped." Business Week. 13 March 1978: 80.

Tholt, Mary E. "Managing the Handicapped." Supervisory Management. October 1978.

Volin, L. K. "Employment of the Handicapped: Concerns for the Industrial Engineer." AIIE Proceedings, 1982 Conference. (23-27 May 1982): 194-198.

Wagel, William H. "Employing the Handicapped." Personnel. (September-October 1977): 45-47.

Wall Street Journal, 6 November 1979; 18 February 1984.

Williams, Arthur. "Is Hiring the Handicapped Good Business?" Journal of Rehabilitation, March, April 1972.

Wolfe, Joe. "Disability Is No Handicap for DuPont." The Alliance Review, Winter 1973-74.

Wysocki, Julie and Wysocki, Paul. "An Employer's Guide to Employment and Disability." Journal of Contemporary Business, Vol. 8, no. 4, 1979, p.64.

Zepke, Brent E. "Affirmative Action for the Handicapped." Industrial Engineering. (August 1977): 30-34.

Government documents

Brown vs. Board of Education. 347 U. S. 483, Washington D. C.: Government Printing Office, 1954.

Diana vs. State Board of Education of California. C-70 37RFP, District of Northern California, 1970.

Hammond , Henry S. The Performance of Physically Impaired Workers in Manufacturing Industries. United States Bureau of Labor Statistics, Bulletin No. 293, 1948.

Hobson vs Hansen. 393 U. S. 801, Washington D. C.: Government Printing Office, 1968.

Mills vs. Board of Education of District of Columbia. 384F Supp. 886, D. D. C., 1972.

Pennsylvania Association for Retarded Children vs. Commonwealth of Pennsylvania. 334F Supp. 1257, E. D. Ua., 1971.

Privacy Act. Public Law 95-38, Statues at Large, Vol. 91, (1977).

Rehabilitation Act. Public Law 93-112, Statues at Large, Vol. 87 (1946).

U. S. Department of Health Education and Welfare. Selected Federal Publications Concerning the Handicapped. Washington, D. C.: Government Printing Office, 1978.

U. S. Department of Health, Education and Welfare. A Summary of Selected Legislation Relating to the Handicapped. Washington D. C.: Government Printing Office, 1975.

U. S. Department of Health, Education and Welfare. Improving

Occupational Programs for the Handicapped. Washington D. C.: Government Printing Office, 1975.

U. S. Department of Labor. The Performance of Physically Impaired Workers in Manufacturing Industries. Washington D. C.: Government Printing Office, 1948.

U. S. Department of Labor. Affirmative Action for Disabled People: A Pocket Guide. (March 1978).

Urban Institute. Comprehensive Needs Study of Severely Disabled Individuals. Washington D. C.: Government Printing Office, 1975.

Quantitative

Books

Aaker, D.A. (ed). Multivariate Analysis in Marketing: Theory and Application. Belmont: Wadsworth, 1971.

Anderson, T. W. An Introduction to Multivariate Statistical Methods. New York: John Wiley, 1952.

_____. Introduction to Multivariate Statistical Analysis. New York: John Wiley, 1958.

Bishop, Y. M. M.; Fienberg, S. E.; and Holland, P. W. Discrete Multivariate Analysis: Theory and Practice. Cambridge, Mass.: MIT Press, 1975.

Bowen, Earl K. Mathematics with Applications in Management and Economics. 3rd edition. Homewood: Richard D. Irwin, 1972.

Cattell, R. B. Handbook of Multivariate Experimental Psychology. Chicago: Rand-McNally, 1966.

_____. Factor Analysis. New York: Harper and Brothers, 1952.

Child, Dennis. The Essentials of Factor Analysis. London: Holt, Rinehart and Winston, 1975.

Dixon, W. J. Biomedical Computer Programs. Los Angeles: University of California Press, 1967.

Enslein, Kurt; Ralston, Anthony; and Wilf, Herbert S. (Eds.). Statistical Methods for Digital Computers (Vol. III). New York: John Wiley and Sons, Inc., 1977.

Gibbons, Jean Dickinson. Nonparametric Statistical Infer-

ence. New York: McGraw-Hill, 1971.

Green, Paul E. Analyzing Multivariate Data. Hinsdale: The Dryden Press, 1978.

Goldstein, Matthew, and Dillon, William R. Discrete Discriminant Analysis. New York: John Wiley, 1978.

Gorsuch, Richard L. Factor Analysis. Philadelphia: W. B. Saunders Company, 1974.

Guilford, J. P. Psychometric Methods. 2nd edition. New York: McGraw-Hill Book Company, 1954.

_____. Fundamental Statistics in Psychology and Education. 4th edition. New York: McGraw-Hill Book Company, 1965.

Hair, Joseph F. Jr.; Anderson, Ralph E.; Tatham, Ronald L.; and Grablowsky, Bernie J. Multivariate Data Analysis. Tulsa: Petroleum Publishing Company, 1979.

Handbook of Quantitative Methods Used in Personnel. Pacific Palisades, California: Compensation Institute, 1979.

Handbook of Job Evaluation Design. Pacific Palisades, California: Compensation Institute, 1980.

Hartley, H. O. Mathematical Methods for Digital Computers. New York: John Wiley, 1962.

Harman, Harry H. Modern Factor Analysis. 3rd ed. rev. Chicago: University of Chicago Press, 1976.

Harris, Richard J. A Primer of Multivariate Statistics. New York: Academic Press, 1975.

Henkel, Ramon E. Tests of Significance. Edited by John L. Sullivan, Quantitative Applications in the Social Sciences Series. no. 4. Beverly Hills: Sage Publications, 1976.

Kim, Jae-On and Mueller, Charles W. Introduction to Factor Analysis: What it is and How to Do It. Edited by John L. Sullivan, Quantitative Applications in the Social Sciences. no. 13. Beverly Hills: Sage Publications, 1978.

Klecka, William R. Discriminant Analysis. Edited by John L. Sullivan, Quantitative Applications in the Social Sciences. no. 19. Beverly Hills: Sage Publications, 1980.

Kleinbaum, David G. and Kupper, Lawrence L. Applied Regres-

sion Analysis and Other Multivariable Methods. North Scituate, Massachusetts: Duxbury Press, 1978.

Kullback, S. Information Theory and Statistics. New York: John Wiley, 1959.

Lachenbruch, P. A. Discriminant Analysis. New York: Hafner Press, 1975.

Levin, Richard I., and Kirkpatrick, Charles A. Quantitative Approaches to Management. 2nd ed. New York: McGraw-Hill, 1971.

Lehmann, Donald R. Market Research and Analysis. Homewood: Richard D. Irwin, Inc., 1979.

Lyczak, Richard A. Elementary Programming for Statistics. North Scituate, Massachusetts: Duxbury Press, 1980.

Marascuilo, Leonard A. Statistical Methods For Behavioral Science Research. New York: McGraw-Hill, 1971.

Nie, Norman H.; Hull, C. Hadlai; Jenkins, Jean G.; Steinbrenner, Karin; and Bent, Dale H. SPSS: Statistical Package for the Social Sciences. 2nd ed. New York: McGraw-Hill, 1975.

Neter, John; Wasserman, William; and Kutner, Michael H. Applied Linear Regression Models. Homewood: Richard D. Irwin, Inc., 1983.

Overall, John E. and Klett, James. C. Applied Multivariate Analysis. New York: McGraw-Hill, 1972.

Press, S. James. Applied Multivariate Analysis. Series in Quantitative Methods for Decision-Making. New York: Holt, Rinehart and Winston, 1972.

Rao, C. R. Advanced Statistical Methods in Biometric Research. New York: John Wiley, 1952.

_____. Linear Statistical Inference and its Applications. New York: John Wiley, 1965.

Savage, I. R. Bibliography of Nonparametric Statistics. Cambridge: Harvard University Press, 1962.

Siegel, Sidney. Nonparametric Statistics For the Behavioral Sciences. New York: McGraw-Hill Book Company, 1956.

Tate, M. W. and Clelland, R. C. Nonparametric and Shortcut Statistics. Danville, Illinois: The Interstate Publishers and Printers, 1957.

Tatsuoka, Maurice M. Multivariate Analysis: Techniques for Educational and Psychological Research. New York: John Wiley and Sons, Inc., 1971.

Van Matre, Joseph G., and Gilbreath, Glenn H. Statistics for Business and Economics. Dallas: Business Publications, Inc., 1980.

Walsh, J. E. Handbook of Nonparametric Statistics. 2nd ed. Princeton: Van Nostrand, 1965.

Weast, Robert C., and Selby, Samuel M. (Eds.). Handbook of Tables for Mathematics (4th ed.). Cleveland: The chemical Rubber Co., 1970.

Winer, B. J. Statistical Principles in Experimental Design. New York: McGraw-Hill, 1962.

Winn, Paul and Johnson, Ross H. Business Statistics. New York: Macmillan, 1978.

Periodicals

Anderson, T. W. "Classification by Multivariate analysis." Psychometrika, 16: 31-50.

Armstrong, J. S., and Soelberg, P. "On the Interpretation of Factor Analysis." Psychological Bulletin, 70: 361.

Arnold, Hugh J., and Feldman, Daniel C. "A Multivariate Analysis of the Determinants of Job Turnover." Journal of Applied Psychology. Vol 67, No. 3, (1982): 350-360.

Bernardin, John H.; Cardy, Robert L.; and Carlyle, Jamie J. "Cognitive Complexity and Appraisal Effectiveness: Back to the Drawing Board?" Journal of Applied Psychology. Vol 67, No. 2, (1982): 151-160.

Blood, Dwight M., and Baker, C. B. "Some Problem in Linear Discrimination." Journal of Farm Economics. 40 (1958): 674-683.

Cochran, W. G. and Hopkins, C. E. "Some Classification Problems with Multivariate Data." Biometrics. 17: 10-32.

Dwyer, Robert F. "Response Errors in Survey Research." California Management Review. (Fall 1980): 39-45.

Ebel, Robert L. "Estimation of the Reliability of Ratings." Psychometrica. Vol 16, No. 4, (1951): 407-424.

Fenwick, Ian. "Techniques in Market Measurement: The Jacknife." Journal of Marketing Research. 14 (August 1979): 410-414.

Ferguson, G. "The Concept of Parsimony in Factor Analysis." Psychometrika, 19(4): 281.

Frane, James W. and Hill, Mary Ann. "Annotated Computer Output for Factor Analysis: A Supplement to the Writeup for Computer Program BMDP4M." BMDP Technical Report #8. Los Angeles: Health Sciences Computing Facility University of California, 1974.

Gorsuch, R. L. "The General Factor in the Test Anxiety Questionnaire." Psychological Reports, 19: 308.

_____. "Data Analysis of Correlated Independent Variables." Multivariate Behavioral Research, 8(1): 89.

Harvey, Robert J. "The Future of Partial Correlation as a Means to Reduce Halo in Performance Ratings." Journal of Applied Psychology. Vol 67, No. 2, (1982): 171-176.

Hom, Peter W.; DeNisi, Angelo S.; Kinicki, Angelo J.; and Bannister, Brendan. "Effectiveness of Performance Feedback From Behaviorally Anchored Rating Scales." Journal of Applied Psychology. Vol 67, No. 5, (1982): 568-576.

Hotelling, H. "The Generalization of Student's Ratio." Annals of Mathematical Statistics, Vol 2., 1931.

Hulin, Charles L. "Some Reflections on General Performance Dimensions and Halo Rating Error." Journal of Applied Psychology. Vol 67, No. 2, (1982): 165-170.

Jennrich, Robert I. "Stepwise Discriminant Analysis." Statistical Methods for Digital Computers. Vol III. Ensling, Kurt, et al, (eds). (1977): 76-95.

Ladd, George W. "Linear Probability Functions and Discriminant Functions." Econometrica. 34(4) (October 1966): 873-885.

Landy, Frank J.; Vance, Robert J.; Barnes-Farrell, Janet L.; and Steele, James W. "Statistical Control of Halo Error in Performance Ratings." Journal of Applied Psychology. October 1980. pp. 501-506.

_____. "Statistical Control of Halo: A Response." Journal of Applied Psychology. Vol 67, No. 2, (1982): 177-180.

Mosteller, Frederick. "The Jacknife." Review of the International Statistical Institute. 39(3) (1971): 363-368.

Morrison, D. G. "On the Interpretation of Discriminant Analysis." Journal of Marketing Research. 6: 156-163.

Murphy, Kevin R. "Difficulties in the Statistical Control of Halo." Journal of Applied Psychology. Vol 67, No. 2, (1982): 161-164.

Nathan, Barry R., and Lord, Robert G. "Cognitive Categorization and Dimensional Schemata: A Process Approach to the Study of Halo in Performance Ratings." Journal of Applied Psychology. Vol 68, No. 4, (1982): 102-114.

Pope, P. T. and Webster, J. T. "The Use of an F-Statistic in Stepwise Regression Procedures." Technometrics, 14(2): 327-340.

Rao, C. R. "Tests of Significance in Multivariate Analysis." Biometrika, 35: 58-79.

Robertson, Thomas S. and Kennedy, James N. "Prediction of Consumer Innovators: Application of Multiple Discriminant Analysis." Journal of Marketing Research. 5 (February 1968): 64-9.

Ronan, W. W.; Anderson, Charles L.; and Talbert, Terry L. "A Psychometric Approach to Job Performance: Fire Fighters." Public Personnel Management. (November-December 1976): 409-422.

Rummel, R. J. "Understanding Factor Analysis." Journal of Conflict Resolution 11 (December 1967): 444-80.

Tukey, J. W. "Bias and Confidence in Not- Quite Large Samples." Annals of Mathematical Statistics. 29 (June 1958): 614.

Welch, B. L. "Note on Discriminant Functions." Biometrika. 31: 218-220.

Wexley, Kenneth N., and Pulakos, Elaine D. "Sex Effects on Performance Ratings in Manager--Subordinate Dyads: A Field Study." Journal of Applied Psychology. Vol 67, No. 4, (1982): 433-439.

Wildt, Albert R.; Lambert, Zarrel V.; and Durand, Richard M. "Applying the Jacknife Statistic in Testing and Interpreting Canonical Weights, Loadings, and Cross-Loadings." Journal of Marketing Research. 19

(February 1982): 99-107.

Zedeck, Sheldon, and Cascio, Wayne F. "Performance Appraisal Decisions as a Function of Rater Training and Purpose of the Appraisal." Journal of Applied Psychology. Vol 67, No. 6, (1982): 752-758.

Dissertations

Bryan, Willie Vern. "The Effects of Short-Term Individual and Group-Counseling on the Self-Concept of Physically Handicapped Workers in a Sheltered Workshop Setting." Ed. D. dissertation, The University of Oklahoma, 1973.

Jackson, Terry Yeargan. "The Effects of an Inservice Model for Regular Physical Educators Working with Handicapped Students in the Mainstream Setting." Ed. D. dissertation, University of Georgia, 1982.

Kerr, Elaine Bookbinder. "The Vocational Experiences of Physically Handicapped--Poorly Educated Workers After Job Placement." Ph. D. dissertation, Columbia University, 1971.

Simon, Alex Joseph. "A Study of the Employment Problem and Work Experiences of the Physically Handicapped in Government and Industry." Ph. D. dissertation, The University of Texas at Austin, 1962.

Tesolowski, Dennis Gregory. "Effects of a Job readiness Training Program on Physically Handicapped Sheltered Workshop Employees." Ed. D. dissertation, Auburn University, 1978.

Vogelson, Myrtle Lifland. "A Comparison of Certain Variables Related to Work of Physically and Psychiatrically Handicapped Selective Placement Applicants." Ph. D. dissertation, New York University, 1962.