PREDICTING THE SELECTION OF A FIELD OF CONCENTRATION AT MICHIGAN STATE UNIVERSITY FROM THE PERSONAL INFORMATION INVENTORY

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ABSTRACT

PREDICTING THE SELECTION OF
A FIELD OF CONCENTRATION AT MICHIGAN STATE UNIVERSITY
FROM THE PERSONAL INFORMATION INVENTORY

by Donald John Cutting

The over-all purpose of this study was to identify through the predictive use of certain elements of self concept, the academic field of concentration that a college student would select. The study was designed to differentiate between criterion groups on the basis of fifteen variables of self concept of ability and occupational interest. The following hypothesis was formulated and tested.

> It is possible to differentiate among groups of students classified by curriculum two years after initial entrance to college, on the basis of an identifiable pattern of self concept of ability and occupational interest as freshmen.

The population selected for this study consisted of the freshmen entering Michigan State University in the Fall of 1963. Of the 5,741 students classified as first-time freshmen, a restricted sample of 2,258 students was chosen for the study. This selection was based on five factors which suited the purpose of the study. A validation subsample of twenty-five per cent was obtained by the selection of every fourth student from the selected sample to be analyzed. The sample had been previously classified by curriculum grouping numbering twenty-seven groups in all.

The instrument used was the Personal Information Inventory which contained the fifteen variables to be used as measures of

self concept. This inventory was administered to all entering freshmen during the Summer Counseling Clinics of 1963. The members of the sample were assigned to groups according to their major two years later in the Fall of 1965.

Multiple discriminant analysis was chosen as the statistical method best suited to the problem of combining test scores and other data so as to maximize the difference between the groups and minimize the difference within each group. Through the separation of individuals who are known to belong to mutually exclusive groups, it is possible to determine the combinations of variables which will maximally discriminate among the different groups. It is also possible to observe the magnitude of the group differences and to classify future individuals into one of these groups on the basis of similar data. All computations for the multiple discriminant analysis were performed by the CDC 3600 computer at Michigan State University.

The analysis yielded ten significant discriminant functions. Thus, the null hypothesis, "There is no difference in self concept of ability and occupational choice, as entering frehmen, among groups of students classified by curriculum two years after initial entrance to college", was rejected. These ten functions were interpreted by an examination of the factor patterns. These functions accounted for over 98 per cent of the total variance or dispersion among groups as defined by the variables. A closer look was given to the first three functions which accounted for approximately 70 per cent of the dispersion among groups. The first function accounted for

approximately 40 per cent of the dispersion and was artistic-social service (feminine) versus numerical-physical science (masculine) in nature. The second function, accounting for approximately 17 per cent of the dispersion among groups, was a verbal-business detail versus biological science-mechanical-technical function. The third function accounted for approximately 13 per cent of the dispersion among groups and was interpreted to be a general (non-numerical) scholastic ability versus business detail-executive-managerial function. These functions were interpreted by plotting the group centroids for the three functions in three-dimensional space. Weighted coefficients were conventionalized and applied to the raw scores of the validation subsample.

The validation was carried out in two separate procedures. The first validation produced a discriminant score for each individual by each of the ten significant discriminant functions. The second validation afforded classification into 27 different groups in rank order with a discriminant function value for each. This second validation was a discriminant classification operation with all ten discriminant functions together performing the differentiation.

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PREFACE

"Trust in the LORD with all thine heart;
and lean not unto thine own understanding.
In all thy ways acknowledge Him,
and He shall direct thy paths."

-- A Proverb of Solomon

ACKNOWLEDGMENTS

The assistance and understanding that has been given by each member of the doctoral committee of the writer is acknowledged with sincere and deep appreciation. Special gratitude is extented to Dr. Ralph E. Kron for his guidance in the formulation of the study and his continued counsel throughout its development. Dr. James W. Costar, for assuming the chairmanship of the doctoral committee when an unforeseen change occurred, Dr. Bill L. Kell, for enduring empathy and continued encouragement, and Dr. Ted W. Ward, for his critical review of the finished thesis, all deserve rich praise. Mr. Bruce Rogers is to be commended for his unreserved assistance in the computer phase of the study.

"And the LORD God said, It is not good that the man should be alone; I will make him an help meet for him." Words are too inadequate to express all that the writer's wife, Norma, has been to him during these days. The Biblical text stands alone. Two sons, Tim and Dan, also deserve recognition for their consideration of the writer during this time of preparation.

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CHAPTER I

THE PROBLEM

Need

In the mainstream of counseling there flows a continual current of concern relative to the selection of a college major. There is a common concern on the part of administrators and students. Student anxiety relates not simply to the initial selection, but also to subsequent major change. As one counsels with these young people it becomes increasingly evident how heavily this decision or choice weighs upon their minds. College administrators, likewise, are faced with meeting student needs in providing for adequate faculty, instructional facilities, and staff. It is imperative that personal, vocational, and academic counseling be available for all students; in coordination with all other administrative procedures. Thus, the earlier the student makes his choice of undergraduate major, and the more clearly defined the choice may be, the better it becomes for all concerned. Prediction and classification are signally important in the counseling of the freshman student.

Purpose

The over-all purpose of this study is to identify through the predictive use of certain elements of self con-

cept, the academic fields of concentration that a college student will select. This will deal with the problem of classification, primarily; that is, to answer the question, "To which group does a person most belong?" This study is not intended to identify the vocational choice of incoming students, or in any way to relate choice of major to such vocational choice. It does not intend to predict the degree of success the individual may expect to enjoy in his chosen field of concentration.

Delimitations

This study is limited to testing a method of predicting the area of concentration for the incoming freshman student. Some significance must be placed upon the fact that the individual's preferences are subject to change. Experience has shown how choice of major may be affected by a change which takes place within the student after entering the freshman year of study. Environmental, social, and academic influences are some of the causative factors. It must be recognized that young people are constantly in a state of change which intensifies with their growth in independence from the family and interdependence with society in general. The application of this change to any prediction that is made may have a profound effect in the end.

Hypothesis

Self-concept theory clearly points up the aspect of individual difference and in turn suggests the reason for differences in academic choice and field of concentration. The

notion has grown that there exists sufficient criteria to discriminate in relation to college, curriculum, or major, depending upon an adequate number for reliability. The choice of curriculum grouping is made on the grounds of this adequacy of membership. The subsequent hypothesis results:

> H_R: It is possible to differentiate among groups of students classified by curriculum two years after initial entrance to college, on the basis of an identifiable pattern of self concept of ability and occupational choice as entering freshmen.

For the purpose of statistical testing, the hypothesis is stated in null for as follows:

> H_0: There is no difference in self concept of ability and occupational choice, as entering freshmen, among groups of students classified by curriculum two years after initial entrance to college.

The null hypothesis assumes that all of the groups of students may be considered members of the same parent population and no differences exist among groups, as entering freshmen, in self concept of abilities and occupational choice.

Upon analysis of the data, if the null hypothesis should be rejected, the difference among groups will be examined. It is expected that these differences will supply a discriminant function in the form of a linear equation which, when applied to the validation sample, will identify the group that the individual student most closely resembles.

Theory

> Adolescence is, clearly, a period of exploration. It is a period in which boys and girls explore the

> society in which they live, the subculture into which they are about to move, the roles they may be called upon to play, and the opportunities to play roles which are congenial to their personalities, interests, and aptitudes.
>
> It would be a mistake, however, to view adolescence solely as a process of finding out "what goes" in the adult world and then adopting these modes of behavior. The adolescent brings a great deal to this world himself: he brings his SELF. What he sees, what he tries, how well he likes it, and how well he succeeds at it, depend upon his self as well as upon the culture.[1]

Donald Super's extensive investigation of the field of vocational choice and vocational counseling has produced significant understanding of development of self concept. It becomes increasingly clear that self concept, even in its emergent stage, influences the young person in many ways. One of these, it is thought, is that choice of an area of concentration upon entry into the university life. Particularly, when faced with a decision which for the most part is his own to make, the student realizes the importance of such choice. It is felt that he calls upon all the resources of his past experience and that his self concept often emerges sovereign to thus influence his choice. For those who are unable to make the choice and who continue in some type of curricular exploration for the first year or two, it is hoped that some measure of direction could be supplied by an analysis of his self concept. Where there has been considerable use of achievement and aptitude test scores in the past for this purpose, this study will apply only measurements of self concept of ability and occupational choice.

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[1]Super, Donald E. THE PSYCHOLOGY OF CAREERS. Harper and Rowe, New York, 1957, p. 81.

Overview

In the foregoing pages of this chapter there has been set forth the problem as it relates to the need, the purpose, the hypothetical setting and the theoretical base.

Following, in chapter two, is a review of the literature dealing with the related studies and the expediency of the use of discriminant analysis.

In chapter three there is presented the methodology of the study. Included is a description of the population and validation sample, together with the instrumentation, the processing of data, and the analytic procedures.

Chapter four includes the analysis of the data and a discussion of the significant findings.

Summary, conclusions, and implications for further research are reported in chapter five.

CHAPTER II

THE REVIEW OF THE LITERATURE

Definition of Terms

The literature is replete with publications which relate to self concept. Books, journal articles, papers, and research are rather profuse. One can find support for almost any position he wishes to take. Although Super may appear to have some special influence in this study, it is not intended that his theoretical position is hereby accepted for the basis of this study. It is felt, however, that Super does present a theoretical position with which this study can closely identify. Self concept as Super suggests is a constellation[1].

> The self-concept system is made up of the various self concepts, the pictures which the individual has of himself in different roles and in different types of situations. Thus it should be noted that it is incorrect to write of the self concept as though each person had just one: each person has a number of self concepts, but one self-concept system at any point in time.

What he is suggesting is that the self concept has, first, a simplicity and, second, a complexity. In its simple form, a self concept is the individual's picture of himself. There seems to be something of a more basic nature, then, in the perception of self. This self percept enables one to

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[1]Super, Donald E.; Starishevsky, Reuben; Natlin, Norman; Jordaan, Jean Pierre. CAREER DEVELOPMENT: SELF-CONCEPT THEORY. New York: College Entrance Examination Board, 1963. p. 19.

see himself in some role, situation, position, or relationship. Thus, as self percepts relate to other self percepts, one acquires a self concept. The self concepts, in turn, abstract and generalize into complex self concepts, organized around some status or role. Super speaks of complex concepts as "...organizations of simple concepts (themselves percepts with accrued meanings), they constitute frameworks into which new percepts are fitted as judgments of relevance are made by the perceiver; .....Self concepts therefore tend to be self-perpetuating and are relatively enduring".[2]

This leads directly into Super's self-concept system which, being general and inclusive, contrasts with the more specific and limited aspect of the self concept. Development takes place as certain self percepts evolve into occupational terms. With this comes the vocational self concept which is often synonymous with vocational preference. Super, however, would decide against this rather absolute identification. He suggests that there is room for accepting or rejecting this position as the individual considers the vocational relevance of the situation.

Since there have been several treatments of the "ego", "self", and "self concept", it is felt that this study should be limited to those definitions which relate to its theoretical base. Table I lists these definitions.

A mere definition does not suffice, either. Combs and

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[2]Super. Ibid., p. 12.

TABLE I[6]

DEFINITIONS OF SELF TERMS

SELF PERCEPT

Primary self percept: unmodified or raw impression of an aspect of the self.

Secondary self percept: simple self concept which has come to function as a percept.

SELF CONCEPT

Simple self concept: organized, related percepts with accrued meaning.

Complex self concept: abstraction from and generalization of simple self concepts, generally organized in a role framework.

SELF-CONCEPT SYSTEM

The constellation, more or less well organized, of all of the self concepts.

VOCATIONAL SELF CONCEPT

The constellation of self attributes considered by the individual to be vocationally relevant, whether or not they have been transplanted into a vocational preference.

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[6]Super, op. cit. p. 19-20.

Snygg[3] say that self concepts are inferred from behavior as contrasted to reported (self report) self concepts. English and English define concept as follows:

> any object of awareness together with its significance or meaning; anything that one can think about that can be distinguished from other things. [4]

It is inconceivable that a self concept, by its inherent nature, can exist without the individual having awareness. Wylie[5] argues for the value of the reported self concept. Her argument is from logic that says that without awareness the individual cannot report, and without reporting how can another know if the individual has a self concept. Inferred self suggests an outsider's concept.

Self-Concept Theory

> Within recent years there has been a resurgence of interest among psychologists in the concept of the self. William James in his famous chapter on the self in Principles of Psychology (1890, Chapter X) set the stage for contemporary theorizing, and much of what is written today about the self and the ego derives directly or indirectly from James. [7]

James' consideration of the self involved the "Empirical Me" and revolved around self-constituents, self-feelings, and actions of self-seeking and self-preservation. From this

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[3]Combs, A. W. and Snygg, D. INDIVIDUAL BEHAVIOR. New York: Harper and Bros., 1959. pp. 440-442.

[4]English, H. B. and English, Ava C. A COMPREHENSIVE DICTIONARY OF PSYCHOLOGICAL AND PSYCHOANALYTICAL TERMS. New York: Longmans, Green & Co., 1958.

[5]Wylie, Ruth C. THE SELF CONCEPT. Lincoln: University of Nebraska Press, 1961. p. 18.

[7]Hall, Calvin S.; Lindzey, Gardner. THEORIES OF PERSONALITY. New York: John Wiley & Sons, Inc., 1960. p. 467.

grand summation, others began to delineate. Lecky[8], although not developing a comprehensive theory of personality, contributed the idea of unification to personality development. In the foreword of Lecky's book, Gardner Murphy says "Lecky had in his own way developed...the conception that the individual must define for himself the nature of that totality which he is. He must throughout life assimilate new experiences in such fashion as both to be and to appear a living unit."[9] There appears to be a close tie in this aspect with Super's idea of the self-perpetuating and enduring nature of self-concept. Following upon Lecky's mid-thirty treatise, Allport "rediscovers" the ego in psychology. Earlier, he had avoided self-concept issues[10] but finally had to face the crucial question "Is the concept of self necessary?"[11] To avoid confusion he takes shelter in his "proprium" which includes bodily sense, self-image, propriate striving, and knowing.

Super positions himself very positively relative to self-concept theory. He views the self concept as a dynamic phenomenon, which is always exerting influence upon the individual according to the stage of life in which he finds himself.[12] The self concept finds its beginning as it develops

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[8]Lecky, P. SELF CONSISTENCY. New York: Island Press, 1945.

[9]Ibid., p. 1.

[10]Allport, G. W. PERSONALITY: A PSYCHOLOGICAL INTERPRETATION. New York: Holt, 1937.

[11]Allport, G. W. "The Ego in Contemporary Psychology," 50 Psychological Review, (1943), 451-478.

[12]Super, Donald E. THE PSYCHOLOGY OF CAREERS. New York: Harper and Bros., 1957. pp. 80-161.

out of the roots of earlier identifications. Probably during adolescence and the attendant exploration, if not earlier, the individual enters into initial ideas of self concept relative to a career. These may not always be realistic or compatible with each other, but through trial and error, the individual sorts out the satisfying elements. Out of that self, then, which each person brings to this world, emerges the self concept as it comes into vital contact with the world of experience around him. Through explorations of many types the self concept grows and widens. A transition takes place as the individual moves from the home into a world of work. Home offered much identification and limited self concept; the school allowed a broadening out of the self concept and associated part-time work enabled further development. With the move from this environment came a time for reality testing both of a cultural and occupational nature. In this framework arises the conflict of aspiration level and achievement. Later it will be established that herein lies the problem with which this study is involved. The implementation of self concept involves an adjustment process in every area of life. With this adjustment comes recognition of reality and the acceptance of those components of the self concept which are compatible with each other. Aspects of the self concept which bring satisfaction are retained, while those which do not bring gratification are in due course rejected and replaced by traits and behaviors which stand the test of reality. One or more of the conflicting traits or behavior patterns is modified in a way

compatible with the rest of the self. This is the process of personality integration[13]. It would appear that the theory of self concept is a theory of personality integration, to the extent that it would involve self-awareness and self-actualization.

From this vantage point one sees the application of such theory to the area of curriculum choice. Torrance[14] described the use of self-concept data in the educational counseling of college students, and concludes as follows:

> Securing self-evaluations from entering college freshmen is a quick, inexpensive procedure, and could well become a part of a college program of evaluating entering freshmen.[15] Its correlates of adjustment and the insight it gives of the individual's own perception of himself add much to the meaning of the results of freshmen test batteries. The device for recording self-estimates places the notion of the self-concept in sufficiently concrete terms to be meaningful to faculty advisers. The techniques for using it can be made sufficiently simple to be useful to faculty advisers and yet potent enough to achieve the depth necessary for modifying self-concepts.

Choice Theory and Career Development

Wrenn[16] indicated that there is not one self concept, but many. In one sense every new role or relationship into which an individual enters may produce a new self concept.

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[13]Ibid., p. 231.

[14]Torrance, E. Paul. "Some Practical Uses of a Knowledge of Self-Concepts in Counseling and Guidance," 14 Educational and Psychological Measurement, (1954), 127.

[15]Michigan State University Summer Counseling Clinics beginning in 1962 have already begun such an evaluation. This study finds its basis in such an evaluation.

[16]Wrenn, Gilbert C. "The Self Concept in Counseling," 5 Journal of Counseling Psychology, (1958), 104-109.

Thus it is possible to conceive of a special, vocational self concept which is composed of those distinctives like attitudes, ideas, feelings, and desires which a person holds about himself and his relationship to a world of work. The self concept has been tied in with various aspects of vocational choice in any number of theories of occupational development. With the use of the Strong Vocational Interest Blank, Carter[17] suggests that inventoried interests of adolescents are organized as are those of adults in various occupations even before they have had experience in those occupations. Bordin[18] also theorized that it would be possible to view all studies of vocational interest inventories as investigations of self concepts in relation to vocational interests; and, when the study is longitudinal or deals with several cross-sections, to relate self concept to vocational development. In more recent days Blocher and Schutz[19] have indicated the similarity between self concept and occupational concept. Super[20] takes an almost absolute position in suggesting that occupational choice is actually an attempt to develop and implement a certain self concept. He

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[17]Carter, H. D. "The Development of Vocational Attitudes," 4 Journal of Counseling Psychology (1940), 185-191.

[18]Bordin, E. S. "A Theory of Interests as Dynamic Phenomena," 3 Educational and Psychological Measurement, (1943), 49-66.

[19]Blocher, D. H. and Schutz, R. A. "Relationships Among Self-Descriptions, Occupational Stereotypes and Vocational Preferences," 8 Journal of Counseling Psychology (1961), 312-317.

[20]Super, Donald E. "Vocational Adjustment: Implementing a Self Concept," 30 Occupations (1951), 88-92.

virtually equates self concept development with vocational development. Definitionally, he speaks of "a reality-tested choice."[21]

Stephenson's[22] presentation of occupational choice as a crystallized self concept establishes implementation of choice or entry as more realistic than simple preference in the Ginzberg theory[23]. In an earlier day Tyler[24] suggested a relationship between aptitudes and interests to build a theory of vocational development around the concept of identity. In more recent times she has reached toward a broader or possibly more basic position in expressing, "the core of individuality consists of a person's choices and the way he organizes them."[25] Her feeling was that practice in choice situations could increase a person's self-awareness and self-direction. The future holds great opportunity for investigating the whole process by means of which the individual sets the pattern for his own further development by the

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[21]Super, Donald E. "A Theory of Vocational Development," 8 American Psychologist (1953), 185-190.

[22]Stephenson, Richard R. "Occupational Choice as a Crystallized Self Concept," 8 Journal of Counseling Psychology (1961), 211-216.

[23]Ginzberg, E.; Ginsburg, S. W.; Axelras, S.; and Herma, J. L. OCCUPATIONAL CHOICE. New York: Columbia University Press, 1951.

[24]Tyler, L. E. "The Development of 'Vocational Interests': The Organization of Likes and Dislikes in Ten-Year Old Children," 86 Journal of Genetic Psychology, (1955), 33-44.

[25]Tyler, L. E. "Research Explorations in the Realm of Choice," 8 Journal of Counseling Psychology (1961), 195-201.

choices he himself makes. In the understanding of choice theory one is led to recognize that the idea of choice is not just single in nature but a succession of choices which sets up the notion of career development. There is not an affluence of literature in this area as there is in occupational and vocational choice. Many of the outstanding contributions in the theory of occupational choice could so easily have reached out to this aspect of choice theory.

Curriculum Choice

The sophistication of the self-concept development, in theory, has almost entirely by-passed, in practice, its implementation to college freshmen for their choice of academic major and field of concentration. This intermediate stage is becoming more critical as the academic preparation of young people becomes more specialized. This critical stage is best expressed in terms of choice of academic major. Borow, et. al.,[26] speaks for an emphasis on self-theory in, counseling students within a framework of occupational psychology which would avoid, to considerable extent, the psychometric patterns as in the General Aptitude Test Battery of the U. S. Employment Service and Strong's Vocational Interest Blank. His colleagues would call for "student development in the educational setting"[27] (Pepinsky) and an inte-

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[26]Borow, H.; Pepinsky, H. B.; and Dressel, P. L. "Frontiers in Personnel Research in Education," in Henry, N. B. (ed.) Personnel Services in Education, 58th Yearbook, Part II (Chicago: National Society for the Study of Education, 1959).

[27]Ibid.

gration of educational experience and self-fulfillment[28] (Dressel). The critical issue appears to be individual difference in the self concept as it relates to choice of academic major. Studies in this field of prediction are rare using differential indices. Some work has been done in predicting success in specific institutions and with specific groups, but, much remains to be done with prediction for new groups.

Multiple Discriminant Analysis

The intention in this study is to utilize the multiple discriminant analysis method as a research tool. Previous research has indicated without question its utilitarian value. Tatsuokoa and Tiedeman[29] have summarized in considerable detail the literature and research of discriminatory analysis. The historical, theoretical, and mathematical development has been handled rather efficiently in a summary by Hodges[30]. One finds considerable overlap in these two summaries but without distress or loss of impact. The literature of this field pertaining to education has been summarized periodically in the REVIEW OF EDUCATIONAL RESEARCH, as well as other publications. The American Council

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[28]Ibid.

[29]Tatsuokoa, M. M. and Tiedeman, D. V. "Discriminant Analysis," 24 Review of Educational Research, (December, 1954), 402-420.

[30]Hodges, Joseph L., Jr. "Discriminatory Analysis: 1. Survey of Discriminatory Analysis, Report No. 1, Project No. 21-49-004, U.S.A.F. School of Aviation Medicine, Randolph Field, Texas, October, 1950.

on Education sub-committee study on prediction of success in professional schools reviews results obtained using various predicters[31]. Baker[32] selected nine studies to review including Rulon, Baggaley, Jackson, Bryan, Tiedeman (Bryan, Rulon), Collister, Christensen, Tiedeman and Bryan, and Dunn. His work of comparing objectives and distinguishing aspects of the research undertaken by each is clearly presented and handled with considerable efficiency.

Kron's report on the literature, as well as the results of his research, although primarily centered in the area of nursing, clearly indicates the advantage of the use of non-intellective variables for research by multiple discriminant analysis.[33] In consideration of the literature as it relates to the use of multiple discriminant analysis, Collister sums it up:

> The multiple discriminant technique requires that all members of the groups in the analysis take the same tests. This technique then uses all of the available information to make inter-group comparisons. The statements that can be made on the basis of discriminant analysis do not concern goodness or badness along the criterion scale. Rather, they concern the belongingness of the individual to the criterion group.... It is suggested that when the major question to be answered concerns the likeness of an individual to a defined

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[31]Stuit, D. B., et. al. "Predicting Success in Professional Schools," American Council on Education, Washington, D. C., 1949.

[32]Baker, Charles D. "Classification into College Major-Areas of Concentration by Means of Multiple Discriminant Function Weighting of College Entrance Test Scores." Unpublished doctoral dissertation, University of Kansas, 1957.

[33]Kron, Ralph E. "Multivariate Classification for Contrasted Success Groups of Student Nurses." Unpublished doctoral dissertation, University of Kansas, 1957.

group from a number of alternative groups, discriminant analysis is more appropriate.[34]

Summary

The foregoing review of literature has consisted of a critical examination of the theory which constitutes the basis for this study. Super[35] has proposed that occupational choices are acts in the implementation of a self concept. The person choosing an occupation does so in the belief that the roles he will play in that occupation will be consistent with his picture of the kind of person he is. Choices will be made to maintain compatibility between occupational roles and self concept.

Although the literature does not suggest any study as ambitious as this having been undertaken, yet, there is evidence to suggest that the time is ripe with the avialability of computer assistance and the ready program of CDC 3600. It may also be noted that Kron demonstrated that when he made use of non-academic test variables there was an important increase in the predictive efficiency of the battery.[36]

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[34]Collister, E. Gordon. "A Comparison of Interest Inventory Scoring Keys Based on Educational and Vocational Groups with Respect to Effectiveness of Classifying Entering College Freshmen Among Alternative Colleges by Multiple Discriminant Analysis." Unpublished doctoral dissertation, Syracuse University, 1952.

[35]Super, op. cit., 1951.

Super, op. cit., 1957.

Super, D. E.; Crites, J. O.; Hummel, R. C.; Moser, Helen P.; Overstreet, Phoebe L.; and Warnath, C. F. VOCATIONAL DEVELOPMENT: A FRAMEWORK FOR RESEARCH. New York: Columbia University, 1957.

[36]Kron, op. cit., pp. 74-75.

It is felt, therefore, that such research of non-intellective factors for the purpose of prediction is highly justified.

Self-concept theory, as Super et al apply to vocational choice, is similarly handled in this study as it relates to curriculum choice. The assumption is made that occupational interest tends to affect academic choice. The instrument was developed on the order of the Strong Vocational Interest areas, and, therefore, presents some occupational stereotypes.

CHAPTER III

DESIGN AND METHODOLOGY OF THE STUDY

THE POPULATION

The population selected for this study consists of the freshmen entering Michigan State University in the Fall of 1963. Five thousand seven hundred and forty-one students were classified as first-time freshmen at Michigan State University during the fall registration period[1].

Sample

In order to best achieve the goals of the study, certain restrictions were placed on the population. The following suggest the delineations which took place for membership in the study sample:

1. All members must have been first-time Michigan State University entering freshmen, in the Fall term of 1963.
2. All members must have attended a Summer Counseling Clinic prior to registering for the Fall term of 1963.
3. All members must have satisfactorily completed the Personal Information Inventory.
4. All members must have been enrolled for classes two years later, Fall term of 1965.
5. All members must have chosen a major area of concentration.

With these qualifications observed, the restricted popu-

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[1]Data obtained from Michigan State University, Office of the Registrar.

lation of the study numbered 2,258 students. This total included male and female and disregarded any demographic or other available data. It is interesting to note that the total number of students registered for the counseling clinics was 4,433 first-time freshmen, and 664 transfer students. The attrition can be attributed to the restriction for membership, the drawing off of a validation sample of 25% by the extraction of every fourth IBM card, and various errors committed during the key punch operations.

Classification of the Sample

In view of the rigid requirements for membership, the sample for analysis is very selected. By nature of the method by which the validation sample was obtained, a true random sample of the selected sample to be analyzed resulted. The method will be noted later.

Entering freshmen in the Fall of 1963 were required to have filled out a Personal Information Inventory if they attended a Summer Counseling Clinic. Those students whose inventories which were filled in completely and with sufficient clarity were checked two years later in the Fall of 1965 to ascertain, first, whether they were enrolled, and, second, their choice of academic major. This choice of academic major was the initial basis for classification into groups. However, it was felt that several of the groups, classified by major, lacked sufficient numbers for reliability. A mixture of unrelated groups could not be justified. Thus, it was felt that homogeneity of groups could be obtained by

enlarging the classification to curriculum groups. In this sense a curriculum is considered to be a cluster of specializations (majors) within a defined discipline of study. The established base for size was set at 30 members.

The final classification used in the analysis and the numbers in the various groups are reported in Table 2. The inclusion of three academic majors among the curriculum groups may be noted[2]. This may be defended on the grounds that their individual size and significant area of specialization set them apart from the curriculum of which they are a member. The randomization of the validation sample was achieved by arbitrarily selecting every fourth IBM card from each of the classified groups[3].

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[2]Appendix A indicates the structure of academic study at Michigan State University.

[3]Students at Michigan State University are assigned student numbers. Each number consists of six digits. The student number of each student whose Personal Information Inventory was complete was punched in the first six columns of an International Business Machine card. The balance of the information from the inventories was also punched into the cards. This included the group classification and variables to be used in the analysis.

TABLE 2

NUMBER OF STUDENTS IN EACH GROUP, CLASSIFIED BY CURRICULUM

GROUP #	CLASSIFICATION	FREQUENCY
1	Agriculture	92
2	*Packaging	57
3	Humanities	45
4	Art	80
5	Literature	105
6	Romance Languages	51
7	History	66
8	Accounting & Financial Administration	76
9	Hotel, Restaurant & Institutional Management	44
10	Business Law, Insurance & Office Administration	136
11	Marketing & Transportation Administration	46
12	Communication Arts	126
13	Elementary Education	257
14	*Special Education	42
15	Health, Physical Education & Recreation	55
16	*Electrical Engineering	55
17	Engineering	77
18	Home Economics	143
19	Biological Sciences	95
20	Physical Sciences	65
21	Mathematics and Statistics	89
22	Nursing	40
23	Social Science	160
24	Political Science	69
25	Psychology	84
26	Social Work	62
27	Veterinary Medicine	41
	TOTAL	2258

*Major areas included in curriculum groupings.

INSTRUMENTATION

In order to achieve the purposes of the study, it is necessary to relate only to the Personal Information Inventory. This inventory lists such data as General Information, Abilities, Activities, and Preferences, Educational Experience and Plans, Occupational Experiences and Plans. The data to be used in the study relates to those self concepts which reflect abilities and occupational choice. Fifteen variables were used; six reflecting self concept of ability and nine indicating self concept in occupational roles. The measurement of self concept of ability in each of the six variates ranks from zero (superior) to four (low). The student was required to arrange the nine occupational roles in rank order according to the way he perceived himself in relation to them. Table 3 gives indication of the means of measuring self concept of abilities. Table 4 indicates the means of rank ordering of occupational roles. In the original form of 1963, the first three choices of occupational roles were required and also an indication of those which were completely rejected, by use of the "X" column. In the 1965 form, a rank ordering of all nine was required. Thus, in order to equate the two forms in a parallel manner, insofar as possible, the 1963 ranking was restructured on the IBM cards so that 1 was punched 1, 2 was punched 2, 3 was punched 3, X was punched 8, and any not chosen were punched 5. This may be justified by considering 8 as the mean of the last three possibilities and 5 as the mean of the intermediate three where there was some uncertainty.

TABLE 3

II. ABILITIES[4]

Compared with other entering students here, I think my general capacity for college work is

0. Superior (Upper 10%) ___ 1. Above Average (Upper quarter) ___ 2. Average (Middle 50%) ___ 3. Below Average (Lower quarter) ___ 4. Low (Lower 10%) ___

Compared to other entering students here, I think my aptitude for solving numerical reasoning problems is

0. Superior (Upper 10%) ___ 1. Above Average (Upper Quarter) ___ 2. Average (Middle 50%) ___ 3. Below Average (Lower quarter) ___ 4. Low (Lower 10%) ___

Compared to entering students here, I think my aptitude for understanding and reasoning words is

0. Superior ___ 1. Above Average ___ 2. Average ___ 3. Below Average ___ 4. Low ___

Comparing my own abilities in these two areas, I do

0. Better in verbal than numerical ___ 1. Equally well in either ___ 3. Better in numerical than in verbal ___.

Compared to other entering students here, I think my reading skill is

0. Superior ___ 1. Above Average ___ 2. Average ___ 3. Below Average ___ 4. Low ___

The grade average I think I will be able to obtain at M.S.U. is

0. A ___ 1. B to B- ___ 2. C- to B- ___ 3. C ___ 4. C- or under ___

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[4]Reproduced from the Personal Information Inventory, Fall 1963, Michigan State University, East Lansing.

TABLE 4

VI. OCCUPATIONAL EXPERIENCES AND PLANS[5]

In the following list select the one group of occupations in which, on the basis of interests and abilities, you believe you best fit. Check it under the first choice. Select the one group of your second choice and mark it under second choice. Mark a third choice too. Then mark under X any group of the six remaining in which you feel you would not fit.

	1st	2nd	3rd	X
Occupation requiring special artistic abilities, such as musician, actor, artist, designer, interior decorator, etc.				
Occupations involving work in physical sciences, such as engineer, chemist, mathematician, physicist, et.				
Occupations involving work in biological sciences, such as zoologist, botanist, nurse, physician, etc.				
Occupations involving mechanical and/or technical skills, such as farmer, aviator, printer, industrial arts, etc.				
Occupations involving social service activities, such as social worker, teacher, personnel man, youth leader, etc.				
Occupations involving business detail, such as cashier, accountant, banker, statistician, stenographer, clerk, etc.				
Occupations involving business contact with people, such as sales, promotional work, politics, etc.				

[5]Reproduced from the Personal Information Inventory, Fall, 1963, Michigan State University, East Lansing. This measurement was loosely derived from the occupational groupings suggested through use of the Strong Vocational Interest Blank, 1960.

TABLE 4 (Continued)

	1st	2nd	3rd	X
Occupations involving verbal or linquistic work, such as lawyer, author, newspaper man, advertising, librarian, etc.				
Occupations involving responsibilities such as director, office manager, foreman, production manager, etc.				

COLLECTION OF DATA

During the Counseling Clinics for freshmen in the summer of 1963, it was requested of the attending students that they fill out the Personal Information Inventory. The data from this instrument were initially gathered by the Michigan State University Counseling Center. Having met the first three restrictions, previously mentioned, those remaining students were checked through the Office of the Registrar to ascertain their acceptability relative to the last two restrictions.

THE STATISTICAL MODEL AND COMPUTATION PROCEDURES

Frances E. Dunn[6] of Brown University established two possibilities for predicting choice of college majors. In this article she discusses the validity of the two procedures. Multiple discriminant analysis was suggested as superior to multiple regression analysis for determining to which group a student seems to "belong". Since there is no idea of predicting success, which the regression method undertakes, it was felt that multiple discriminant analysis best suited our needs. Multiple discriminant analysis is a statistical method of combining test scores or other data so as to maximize the differences between the groups and minimize the difference within each group. Through the separation of individuals who are known to belong to mutually exclusive groups, it is possible to determine the combina-

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[6]Dunn, Frances E. "Two Methods for Predicting the Selection of a College Major," 6 Journal of Counseling Psychology, (June, 1959), 15-27.

tions of variables which will maximally discriminate among the different groups. It is also possible to observe the magnitude of the group differences and to classify future individuals into one of these groups on the basis of similar data. In this study, individuals had been classified according to curriculum choice two years later at Michigan State University.

A set of fifteen measurements for each member of twenty-seven defined and mutually exclusive groups was collected.[7] The study required a statistical approach which would give maximum discrimination among the twenty-seven groups on the basis of the information available. The intensity and direction of the difference also was vital. Because of the nature of the interrelationship between the variables, it was viewed as necessary to use a technique which would identify basic, independent factors which accounted for group differences.

Description of Multiple Discriminant Analysis

Computations required for obtaining discriminant functions, when a large number of groups and variables are being studied, are such that modern card-punching and/or electronic equipment is needed[8]. This analysis produces discriminants of such linear nature as to weight the variates and

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[7]See Table I

[8]Computer Institute for Social Science Research, Michigan State University, Technical Report 33, "DISCRIM: MULTIPLE DISCRIMINANT ANALYSIS," Programmed by Dr. P. Lohnes, University of Buffalo; Modified for CDC 3600 by A. V. Williams, CISSR. Language: 3600 FORTRAN. October 26, 1965.

produce the greatest amount of separation among the fields possible with the data used. When the weights are then applied to test scores of a new student, the resultant discriminant scores would suggest to which group the individual most likely belongs. This study will not include the detail of the computational procedure involved to develop such statistical elements as intercorrelation matrix, means, standard deviations, variances and co-variances, A matrix, W matrix, etc., since this was handled by the CDC 3600 programming. This basic information is available in several different presentations.

Ikenberry[9] clearly dessribes the multiple discriminant analysis computational procedures required to solve the determinantal equation. He follows clcsely the procedures

$$|A - \lambda W| V = 0.$$

provided by Bryan[10] in his doctoral dissertation and an Air Force research report by Bryan, Rulon, and Tiedeman.[11] A comprehensive treatment of the development and perfection of multiple discriminant analysis technique has been pub-

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[9]Ikenberry, Stanley O. "A Multivariate Analysis of the Relationship of Academic Aptitude, Social Background, and Attitudes and Values of Collegiate Persistence." Unpublished doctoral dissertation, Michigan State University, 1960.

[10]Bryan, Joseph G. "A Method for the Exact Determination of the Characteristic Equation and Latent Victors of a Matrix with Applications to the Discriminant Function for More than Two Groups." Unpublished doctoral dissertation, Harvard University, 1950.

[11]Tiedeman, David V.; Bryan, Joseph G.; and Rulon, Phillip J. "The Utility of the Airman Classification Battery for Assignment of Airmen to Eight Air Force Specialties." Cambridge, Mass.: Educational Research Corporation, June, 1951.

lished by Tatsuokoa and Tiedeman.[12]

Assumptions of the Statistical Model

The assumption is made for normality of distribtuion of test scores of the population to produce equal variance and co-variance matrices. No method to test the assumption was found in the literature, or in the review of previous studies using multiple discriminant analysis. Ikenberry[13] refers to a correspondence with David V. Tiedeman discussing the availability of a method of testing the assumption as well as the advisability of testing the assumption. Negative response precluded further activity. It was therefore determined to assume multivariate normal distribution and equality of variance-covariance matrices based upon the lack of tests.

SUMMARY

This study involved a population of first-time entering freshmen of the Fall, 1963, at Michigan State University. It was required that membership in the sample include attendance at a freshman counseling clinic prior to fall registration as well as being registered for courses two years later in the Fall, 1965, with a declared major field of concentration.

This sample was classified according to curriculum. This established twenty-seven mutually exclusive groups.

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[12]Tatsuokoa, Maurice and Tiedeman, D. V. "Discriminant Analysis," 24 Review of Educational Research, (December, 1954), 402-420

[13]Ikenberry, op. cit., p. 72.

Selection of every fourth student allowed for the provision of a validation sample. This sub-sample also retained its mutually exclusive group nature at the same time being representative of the sample under analysis.

The instrument used in this study was the Personal Information Inventory. The measurements were of the nature of self concept of ability, and interest. Six of the former and nine of the latter gave a total of fifteen variables.

The analysis of the data was performed through the implementation of multiple discriminant analysis. Computational procedures were accomplished through use of the Michigan State University computer CDC 3600.

CHAPTER IV

THE ANALYSIS OF THE DATA

The multiple discriminant analysis program known as Discrim and modified for use with CDC 3600 includes in the printed output a total correlation matrix indicating the interrelationships among the variables. As a matter of record, group means on each of the variables used in the study are presented in Appendix B. The total intercorrelation matrix of the fifteen variables used in the study may be found in Table 5 to assist in understanding the basic relationships of the variables. Generally, there appears to be some close relationship between the self-concept variables in the area of ability. Some extension of this may also be noted upon consideration of the physical sciences interest variable. It may also be noticed that those variables, seven through fifteen, which reflect occupational interests are significantly lower in regard to interrelationship. One might assume that it may be possible to collapse the ability variables into one, using the General Ability variable as a measurement of self concept of ability along with the occupational interest variates to discriminate substantially the same as the fifteen variables did. However, later consideration of the test of hypothesis will not allow for this collapsing to be justifiable.

TABLE 5

COEFFICIENTS OF TOTAL INTERCORRELATION AMONG THE VARIABLES USED IN THE STUDY*

VARIABLES	1	2	3	4	5	6	7
1. General Ability							
2. Numerical Reasoning	.465						
3. Verbal Reasoning	.502	.112					
4. Comparison of 2 & 3	-.007	-.553	.422				
5. Reading Skill	.457	.108	.599	.302			
6. Grade Average at MSU	.559	.385	.371	-.032	.335		
7. Artistic	-.057	-.185	.021	.167	.033	-.072	
8. Physical Sciences	.160	.441	-.030	-.406	-.035	.167	-.164
9. Biological Sciences	.022	-.005	.017	.022	-.017	.048	-.081
10. Mech/Tech Skills	-.071	.013	-.098	-.115	-.097	-.048	-.040
11. Social Service	-.092	-.230	-.033	.193	.005	-.121	-.0008
12. Business Detail	-.098	-.026	-.126	-.065	-.117	-.126	-.087
13. Business Contact	-.011	-.103	.042	.118	.028	-.033	-.045
14. Verbal & Linguistic	.105	-.083	.185	.216	.154	.082	-.053
15. Executive-Managerial	-.058	-.016	-.034	-.024	-.041	-.065	-.070

*Significance established using 1000 degrees of freedom.

TABLE 5 (Continued)

VARIABLES	8	9	10	11	12	13	14	15
1. General Ability								
2. Numerical Reasoning								
3. Verbal Reasoning								
4. Comparison of 2 & 3								
5. Reading Skill								
6. Grade Average at MSU								
7. Artistic								
8. Physical Sciences								
9. Biological Sciences	.013							
10. Mech/Tech Skills	.059	.037						
11. Social Service	-.277	-.126	-.159					
12. Business Detail	-.067	-.142	-.065	.015				
13. Business Contact	-.181	-.158	-.091	-.021	-.017			
14. Verbal & Linguistic	-.182	-.164	-.083	-.014	-.096	.040		
15. Executive-Managerial	-.090	-.156	-.033	-.134	.031	.001	-.033	

Based upon the appropriate F test, a correlation coefficient of .081 is significantly different from zero at the 1% level of confidence. A coefficient of .062 is significant at the 5% level of confidence.[1] Accordingly, the percentage of significance among the six self concept of ability variables is 86.7%. In comparison, the percentage of significance among the nine self concept of interest variables is 47.2%, and the percentage of significance between all fifteen variates amounts to 46.3%.

RESULTS OF THE MULTIPLE DISCRIMINANT ANALYSIS

The Test of the Hypothesis

As indicated in Chapter Three, the within and among matrices were computed in the Discrim Program by CDC 3600.[2] These matrices along with the balance of the output are available for ready reference through the Michigan State University Counseling Center.[3] The solution of the determinantal equation, $|A - \lambda W| V = 0$, was also a part of the computation output by CDC 3600. This solution was required for the test of the hypothesis of the study. Stated in null form, the hypothesis stated the following:

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[1]Arkin, Herbert and Colton, Raymond R. TABLES FOR STATISTICIANS, COLLEGE OUTLINE SERIES. New York: Barnes & Noble, Inc., 1950. p. 140.

[2]Computer Institute for Social Science Research, op. cit.

[3]The complete set of data is filed with Dr. Ralph Kron, Michigan State University Counseling Center. This volume of data includes all raw data punched on IBM cards as well as the total output both of the discriminant analysis and the validation samples.

There is no difference in self concept of ability and occupational interest, as entering freshmen, among groups of students classified by curriculum two years later.

Rao has established a test of statistical significance of the latent roots, or discriminant functions, to test multivariate discrimination among several groups.[4] This test of statistical significance of the latent roots makes use of the following equation, using chi square.

$$X^2 = \left| N - \tfrac{1}{2} (p - k) \right| \log_e (1 - \lambda)$$

N= the total sample of 2258 individuals
p= the total number of 15 variables
k= the total number of 27 groups
λ = the latent root or discriminant function

A chi square value for each root was derived by this formula and referred to a distribution table of chi square values. Table 6 indicates the significance level obtained for each function or latent root. The table also lists the chi square value, the degrees of freedom, and rank ordering of the latent roots or discriminant functions.

Nine discriminant functions show significance beyond the .001 level of confidence. The tenth function is significant at the .05 level such that $.05 > P > .02$. The last five remaining roots do not show statistical significance by reason of their lower magnitude. These five functions were not included in the interpretation since they could represent chance variation.

Considering the sum of the latent roots as an estimate

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[4]Rao, C. Radhakrishna. ADVANCED STATISTICAL METHODS IN BIOMETRIC RESEARCH. New York: John Wiley & Sons, Inc., 1952. pp. 372-72

TABLE 6

LATENT ROOTS, CHI SQUARE VALUES, DEGREES OF FREEDOM AND STATISTICAL SIGNIFICANCE LEVELS FOR EACH OF THE FIFTEEN DISCRIMINANT FUNCTIONS

Discriminant Function	λ	X^2	D. F.	Significance Level
V_1	.756	1252.72	40	.001
V_2	.317	603.99	38	.001
V_3	.241	492.14	36	.001
V_4	.185	380.29	34	.001
V_5	.150	313.18	32	.001
V_6	.087	178.96	30	.001
V_7	.044	89.48	28	.001
V_8	.035	67.11	26	.001
V_9	.027	58.162	24	.001
V_{10}	.017	35.792	22	.05
V_{11}	.014	29.081	20	.1
V_{12}	.007	15.659	18	.75
V_{13}	.007	15.659	16	.5
V_{14}	.004	8.948	14	.9
V_{15}	.003	6.711	12	.9

of the total variance or dispersion among groups[5] the percentage accounted for by each root can be computed. Table 7 lists the percentage of variance accounted for by each latent root. Accordingly, the first discriminant function accounts

TABLE 7

LATENT ROOTS IN RANK ORDER BY CORRESPONDING PERCENTAGE OF VARIANCE

Discriminant Function	Level of Significance	Latent Root Value	Percentage of Trace	Cumulative
V_1	.001	.756	39.8630	39.8630
V_2	.001	.317	16.7413	56.6043
V_3	.001	.241	12.7268	69.3311
V_4	.001	.185	9.7562	79.0873
V_5	.001	.150	7.9100	86.9973
V_6	.001	.087	4.5939	91.5912
V_7	.001	.044	2.3235	93.9147
V_8	.001	.035	1.8494	95.7641
V_9	.001	.027	1.4003	97.1644
V_{10}	.05	.017	0.9204	98.0848
V_{11}	.1	.014	0.7497	98.8345
V_{12}	.75	.007	0.3916	99.2261
V_{13}	.50	.007	0.3837	99.6098
V_{14}	.90	.004	0.2170	99.8268
V_{15}	.90	.003	0.1730	99.9998

for approximately 39.9 per cent of the dispersion among groups; the second discriminant function would account for 16.7 per cent of the total dispersion; 12.8 per cent of the total dispersion by the third discriminant function. The last five functions fall below the accepted level of significance and account for less that 2 per cent of the total dispersion among groups..

[5]Ibid., p. 372.

Accordingly, the null hypothesis was rejected since it is possible to differentiate among groups of students. Subsequently the interpretation of the discriminating functions which are significant to the differentiation will be presented. The solution of the determinantal equation produced a Wilks Lambda equal to 0.2008584 for the test of the hypothesis of over-all group differences. For test of hypothesis, F = 9.7285856 which greatly exceeds the F value for significance of 1.19. Again the null is rejected.

Saupe[6] states that each significant function is orthogonal to all the other functions of the analysis. The following Table 8 of F ratios of among/within means squares establishing significant difference for each variable supports the assumption of Saupe's statement. The appropriate F test sets a significant value of 1.53 at the .05 level of confidence using 26 and 2231 degrees of freedom. Cooley and Lohnes[7] establish the relative contributions of the original variates to the discriminant functions. With the research hypothesis established, interpretations of functions is approached. An interpretation is made of only the first ten discriminant functions.

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[6]Saupe, Joe L. "Factoral-Design Multiple-Discriminant Analysis: A Description and an Illustration," 2 American Educational Research Journal, #3 (May, 1965), 176.

[7]Cooley, William W. and Lohnes, Paul R. MULTIVARIATE PROCEDURES FOR THE BEHAVIORAL SCIENCES. New York: John Wiley and Sons, 1962. p. 211.

TABLE 8

F RATIOS USED TO DETERMINE SIGNIFICANT DIFFERENCE OF VARIABLES

Variable	Among Means Square	Within Means Square	F Ratio	
1	3.563	0.322	11.05	
2	10.473	0.478	21.91	
3	4.329	0.410	10.55	F value
4	16.727	0.647	25.86	
5	3.021	0.423	7.13	1.53
6	3.906	0.460	8.50	
7	43.564	2.422	17.98	at
8	97.368	2.661	36.59	
9	60.678	3.019	20.10	.05
10	26.038	2.100	12.40	
11	94.632	3.850	24.58	confidence
12	32.664	2.949	11.08	
13	14.546	2.873	5.06	level
14	40.599	3.027	13.41	
15	18.046	2.832	6.37	

Number of degrees of freedom are 26 and 2231 -

INTERPRETATION OF THE SIGNIFICANT DISCRIMINANT FUNCTIONS

Interpretation of the discriminant functions may be undertaken by an examination of the conventionalized coefficients weighted by the standard deviation of the corresponding variable. Tiedeman and Bryan comment on the interpretation of discriminant functions as follows:

> It can be shown that the individual values of the discriminant function are independent of the units of measurement, and origin of coordinates of the initial variates, since the coefficients automatically adjust themselves (linearly) to the scales employed. On the other hand, the interpretation of separate coefficient does depend on the units of the initial variates.[8]

[8] Tiedeman, David V. and Bryan, Joseph C. "Predictions of College Field of Concentration," 24 Harvard Educational Review, (Spring, 1954), 132.

Their conclusion is that interpretation of functions may be made directly from the conventionalized coefficients. Since the variables used in this study did not have similar or comparable units of measurement, a weighting procedure to obtain conventionalized coefficients was necessary. The discriminant coefficients were divided by the value of the largest coefficient which gave a value of 1 for that coefficient and subsequent lesser values for the other coefficients. Weighted, or multiplied, by its standard deviation, each instrument produced a conventionalized coefficient for each discriminant function. The conventionalized discriminant coefficients for all ten discriminant functions are to be found in Appendix D of this study. Appendix C presents the standard deviations of the variables. Ikenberry[9], using three discriminant functions, gave a clear demonstration of this method of interpreting discriminant functions.

Interpretation of Factor Patterns of Discriminant Functions

Since this study has produced ten significant discriminant functions, it was felt that interpretations of those functions could be more adequately handled by a consideration of the factor patterns of each discriminant function. Since the first three functions account for approximately 70 per cent of the total dispersion among groups, one might expect the factor patterns of these three functions to be more productive of interpretive information than the others. Table 9 is composed of the coefficients making up the factor

[9]Ikenberry, op. cit., p. 79-86.

TABLE 9

FACTOR PATTERN FOR DISCRIMINANT FUNCTIONS

Variable No.	Name	1	2	3	4	5	6	7	8	9	10
1	General Ability	-0.2277	0.1693	0.5920	-0.0246	-0.1922	-0.2146	0.0718	0.3939	-0.0866	0.0547
2	Numerical Ability	-0.6359	0.0711	0.2028	0.0975	-0.2589	-0.2190	0.1599	0.2226	-0.2690	-0.0377
3	Verbal Ability	0.1441	0.1296	0.6233	-0.1564	0.0391	-0.1303	-0.0412	0.5915	0.3576	-0.0672
4	V - N Comparison	0.6813	0.0477	0.2999	-0.1962	0.1359	0.1574	-0.0518	0.0274	0.1972	0.0671
5	Reading Ability	0.1520	0.1747	0.4850	-0.1357	-0.0603	-0.0157	-0.1350	0.2416	0.1861	0.5639
6	Grade Average	-0.2158	0.0711	0.5098	-0.0058	-0.2004	-0.2007	0.1598	0.2856	-0.1538	0.3488
7	Artistic Interests	0.3876	-0.0868	0.0677	0.5948	0.5665	-0.2940	0.1609	0.0254	-0.1564	0.0205
8	Physical Science Int.	-0.7728	-0.0258	0.2718	0.3767	-0.1136	0.0772	-0.1122	-0.1924	0.1253	-0.0258
9	Biological Science Int.	0.0058	-0.7913	0.1692	-0.3216	-0.1796	-0.3814	0.0265	-0.1761	0.0097	-0.0278
10	Mechanical-Technical Int.	-0.2748	-0.4012	-0.1883	-0.1119	0.2828	0.5667	0.3782	0.3165	-0.0721	0.0395
11	Social Service Interest	0.5819	-0.0176	-0.0843	0.3417	-0.6102	0.2976	-0.0943	0.1106	-0.0713	-0.1663
12	Business Detail Interest	-0.0155	0.3543	-0.5359	-0.0158	-0.2732	-0.2991	0.4503	0.0654	0.2379	0.0925
13	Business Contact Interest	0.1288	0.2815	0.0080	-0.2651	0.0827	0.0256	-0.2508	0.2080	-0.6203	0.0801
14	Verbal Linguistic Int.	0.2178	0.4258	0.4419	-0.3335	0.0835	0.1831	0.3965	-0.3323	-0.0543	-0.2519
15	Executive-Managerial Int.	-0.1007	0.2565	-0.3315	-0.2392	0.1942	-0.1440	-0.4154	0.0614	-0.0416	-0.2760

pattern for the ten significant discriminant functions. The approach to interpretations of factor patterns uses only those loadings greater than the range of ± .3000.

Function one might well be considered to be a feminine-masculine dimension. There appears to be strong social service and artistic interests contrasted to low self concepts of numerical ability and of related physical science interests. The high verbal-numerical loading on the negative pole would indicate that verbal self-concept alone has little effect in the discriminating power of this function.

The second discriminant function indicates a verbal versus scientific interests contrast. The verbal linguistic interest and business detail interest are contrasted with the negatively weighted biological science interest and mechanical-technical skills areas.

The third function is weighted with high factors of non-numerical, general scholastic and verbal qualities. The function points up a sharp contrast between the verbal linquistic interest and the business detail and executive-managerial interests. It is evident that a discrimination between verbal linguistic and business detail interests takes place in this function as compared with function two for the same interests.

The fifth function is clearly artistic in nature in contrast with a social service interest. Here again one sees the discriminatory effect of one function as contrasted with another function. These same two areas are both positively weighted in function one. Function four, on the other hand,

although weighting both of these factors positively also includes the physical science interest which in function one was negative and opposed to the artistic and social service. The negative aspect of biological science and verbal linquistic interests in function four serves as an interesting contrast to their opposite polarity in function two.

The factor pattern of function six brings to bear the mechanical-technical interest in contrast to biological science interest; again, there is a separation as compared with their identification in function two.

Function seven shows a business detail interest strengthened by mechanical-technical interests versus executive-managerial interests. An interesting comparison is noticed when function three is considered here.

Verbal and general ability concepts and mechanical-technical interests are opposed by verbal linguistic interests in function eight. A combination of factors of this nature might discriminate well for engineering, for example.

Function nine presents verbal ability in contrast with business contact interest. Reading ability with self concept of grade average support is the discriminating nature of ten.

Considerable speculation is possible when one relates these factor patterns to the clustering approach of interpreting the Strong Vocational Interest Blank.

Interpretation of Group Centroids

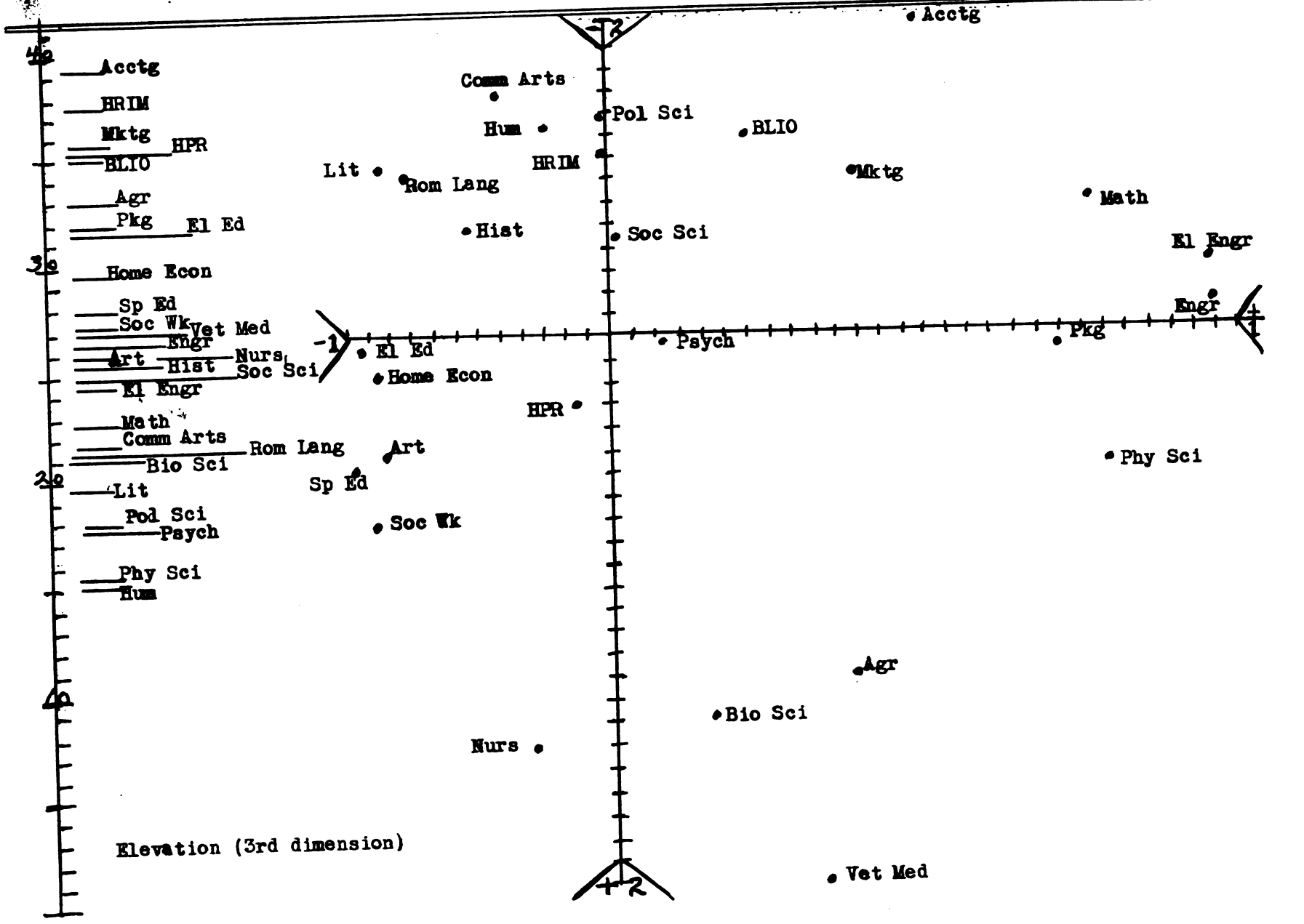
In the interest of clarity this interpretation will be

limited to three discriminant functions since it involves plotting of group centroids in dimensional space. To begin, group differences will be noted in relation to the first two discriminant functions and the third will be discussed later. The position of each of the twenty-seven groups in two-dimensional space as established by the first two discriminant functions has been plotted in Figure I. It becomes apparent that the first function, previously seen as being weighted by social service and artistic interests, differentiates clearly from the physical science groups. The strong rejection of the numerical factor pattern tends to reinforce the identification of the verbal with the social service and artistic as noted in Figure I. There appears to be significant bi-polar discrimination with business interests and biological science interests coming in between. The horizontal plotting of the first function points out a sex differentiation also. In the fourth quadrant, particularly, a cluster of groups dominated by the female sex is apparent, while the predominantly male cluster is far to the right.

The second discriminant function, plotted vertically, effectively differentiates between business and verbal interests at the top of Figure I and biological scientific groups at the bottom. Again, in the center, are those independents which tend to identify with both of the extremes. The extreme polarity of nursing, biological science, and veterinary medicine on the one hand, and accounting (business detail interest) and communication arts, literature, political science (verbal\linguistic interests) on the other,

FIGURE I

GROUP CENTROIDS IN TWO-DIMENSIONAL SPACE



support the previous interpretation of the second function by factor patterns.

The third discriminant function, plotted as an elevation arising out of the intersection of the other two-dimensional plotting allows for some interpretation in the third dimension. Conceiving the group centroids as clustering in space, there appears to be several balloon-like clusters. The largest of these includes the groups of elementary education, special education, home economics, art, and social work. Nursing, veterinary medicine, and biological sciences constitute another. Mathematics, engineering, and electrical engineering make up a third. Accounting, marketing, and BLIO form another. Literature and romance languages make still another. The group centroid values are presented in Appendix E.

THE VALIDATION

The over-all purpose of this study was to attempt to identify appropriate academic fields of concentration that a college student might select. Having obtained discriminant functions from an analysis of the parent sample and weighting them appropriately, these functions were used to classify each individual of the validation subsample as a member of one of the criterion curriculum groups. This classification was compared with actual group membership of each member of the subsample. Two separate validations were performed.

The First Validation - by comparing sums of products[10]

In the first validation, a set of discriminant scores was computed for each individual by using the weighted conventionalized coefficients and the raw scores of the variables used for measurement. This computation resulted in a discriminant score from each of the ten significant functions for each individual in the subsample. In a comparable manner, a set of scores was derived for each group using the means of each group and the weighted coefficients. Mean discriminant scores for each of the twenty-seven groups of the individual score with the group mean score one can attempt classification of the individual in that group. The group mean to which the individual score comes closest is the group in which he has membership. The validation is essentially a problem of correct assignment to a group. The probability of chance "hitting" of the correct group is 1 in 27, or 3.70 per cent. The total number of hits in all 27 groups amounted to 331. The total subsample amounts to 567 which results in the percentage of "correct" hits as being 58.4 per cent. A complete picture of the "correct" hits by group and function is seen in Table 10.

However, one cannot assume that there was not duplication of "hits" by different functions. Therefore, considering the 5670 possibilities for "hits" a percentage of 5.8 resulted. To circumvent this confusion which arises when

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[10]Computer Institute for Social Science Research, Michigan State University, East Lansing, Michigan. Technical Report 25, PRECOMPILING PROGRAM FOR MATRIX MANIPULATION, by Alan M. Lesgold. August, 1965.

TABLE 10

CLASSIFICATION OF VALIDATION SUBSAMPLE

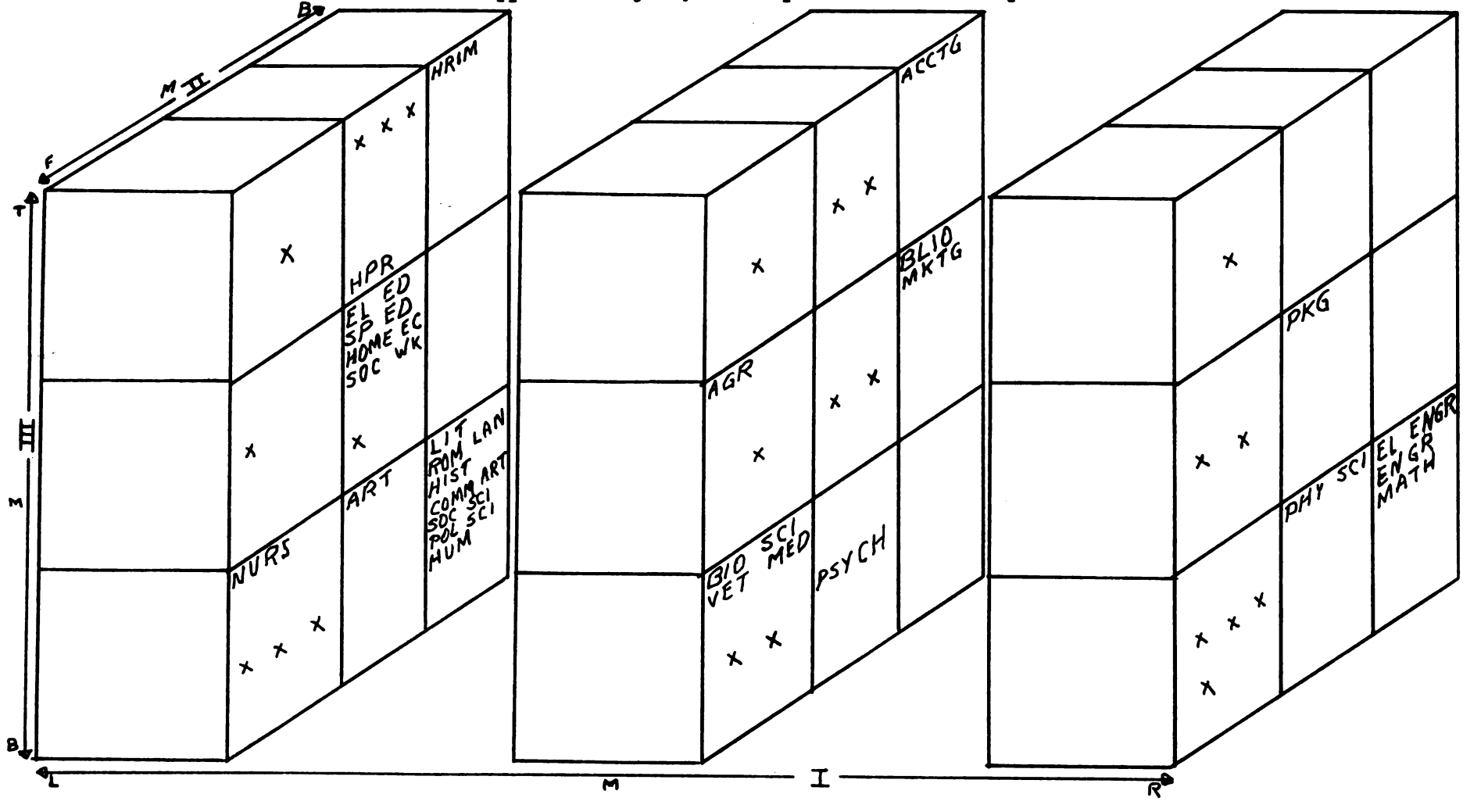
Name	Group No.	N	Discriminant Functions 1	2	3	4	5	6	7	8	9	10	Total
Agr	1	24	0	4	1	0	0	2	1	3	1	2	14
Pkg	2	14	0	1	2	0	0	0	0	0	0	0	3
Hum	3	11	0	0	0	0	0	0	0	0	0	0	0
Art	4	20	0	0	0	0	7	1	0	0	1	0	9
Lit	5	26	0	2	0	1	0	0	0	0	0	1	4
Rom Lan	6	13	1	0	0	0	0	1	0	0	1	0	3
Hist	7	17	0	0	2	1	0	1	1	0	1	0	6
Acctg	8	19	0	7	1	0	0	4	1	0	0	4	17
HRIM	9	11	1	0	0	0	1	0	0	0	0	0	2
BLIO	10	34	1	1	6	0	0	4	0	0	2	0	14
Mktg	11	11	0	0	0	0	1	0	0	0	0	0	1
Com Art	12	31	2	1	0	1	0	1	4	0	0	0	12
El Ed	13	66	42	0	1	9	20	0	17	2	0	3	94
Sp Ed	14	11	3	0	0	0	0	0	0	1	1	7	12
HPR	15	14	1	0	0	1	2	3	0	0	0	1	8
El Engr	16	19	0	0	0	0	2	1	0	2	1	1	7
Engr	17	14	5	1	1	0	0	3	0	6	4	0	20
Home Ec	18	36	0	6	3	4	0	0	7	2	21	0	43
Bio Sc	19	23	1	0	1	0	1	2	0	0	2	1	8
Phy Sc	20	17	2	0	4	1	1	0	0	0	0	0	8
Math	21	22	2	1	0	0	0	0	0	0	1	0	4
Nurs	22	10	0	2	0	0	0	10	0	0	0	0	12
Soc Sc	23	40	1	1	0	0	0	0	1	0	0	2	5
Pol Sc	24	17	0	0	1	0	0	0	2	0	0	0	3
Psych	25	21	0	0	0	1	1	0	0	1	0	0	3
Soc Wk	26	16	0	3	1	2	1	0	0	0	0	0	7
Vet Med	27	10	0	6	0	3	1	0	1	0	0	1	12
Total		567	62	39	24	24	38	33	35	17	36	23	331

one attempts for direct "hits", it was felt that a projection of groups into three dimensional space, by thirds of the range of values of group means, offered much promise and clarity. Figure II indicates the cell in which each of the 27 group means are located in three-dimensional space. The first function gives separation from left to right, in thirds. The highest third was plotted to the right. The second function discriminates from front to back, in thirds. The highest third of the second function is plotted to the front. The third function differentiates on the vertical plane, in thirds. The highest third is at the top. The twenty-seven values (group means) for each discriminant function were arranged in rank order and the range was divided into thirds in order to establish the cell block form. The group means were then plotted according to the third of the distribution in which the means would fall. This was done sequentially by discriminant function. Each group was then coded according to the position of the cell in which it was plotted, e.g., Accounting - M B T (middle third, back third, and top third). In a similar manner, each individual in the validation subsample was coded. By simple visual comparison of codes, it was established whether a "hit" had occurred.

The plotting of the groups indicated that there were rather significant clusters where groups appeared to identify with other groups. With this concept before us, it was felt that prediction of the individual student to a cluster might be somewhat practical. Accordingly, five

FIGURE II

Three-Dimensional Plotting of Group Means
On The First Three Discriminant Functions, Accounting For
Approximately 70% of Dispersion Variability



clusters were formed and one isolated cell was maintained. Of the 567 individuals in the subsample, 183 were found to be "hits". This amounts to a correct prediction of 32.2 per cent, without any duplication involved. Table 11 presents the details of each cluster. Most significant was the verbal-linguistic, arts and letters cluster with 52 per cent "hits".

The lack of "hits" in the psychology group may be accounted for in the light of the closeness of the psychology cluster to the clusters of physical science, biological science, arts and letters-social science (Figure II).

Chance probability for hits, considering six possible clusters, would be 1 in 6 or 16.6 per cent. By comparison, the 32 per cent prediction was double the chance probability. The chance probability for hits, considering 27 possible cells was 1 in 27 or 3.70 per cent.

The first group of 24 individuals which composed the Agriculture group in the subsample for validation was plotted by X's in the cells in which the first three functions placed them (see Figure II). Some thought was given concerning those which were in close proximity to the cluster. It was felt that any unidentified cell immediately adjacent to a cell with identifiable curriculum might well reflect the aura of the cluster involved. Should that cell be adjacent to two such clusters, the notion was held that there might be interdisciplinary study suggested. The counselor with such a tool at his disposal could readily present such ideas to an entering student for his consideration. The two

plottings in the very center cell of Figure II, being adjacent to four clusters, could suggest the possibility of an interdisciplinary curriculum leading to science teaching, agricultural economics or business, business teaching, or agricultural education to mention just a few.

When one considers the large number of entering freshmen who select "no preference" as a major, this means of prediction becomes quite significant. It suggests that as few as 1/3 of those "no preference" students could be directed into consideration of an area of study with some justification. A somewhat larger percentage might be reached when such an instrument is used by the counselor and the student to gain insight. This notion of insight becomes the more meaningful when one considers the fact that in the academic year 1964-1965 a memo issued by University College on changes of major[11] indicates 2947 students changed major moving either into or out of the "no preference" area.

The Second Validation - a discriminant classification operation[12]

The second validation differs from the first in a pro-

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[11]Memo from University College, Michigan State University, East Lansing, Michigan. Major Changes - Fall 1964-Fall 1965, North and South Campus. The memo lists 5535 changes of major, among and within ten colleges.

[12]Program DISCRAS, under preparation for inclusion in the Program Library of the Michigan State University Computer Institute for Social Science Research: Programmed by Alan Lesgold and Stuart Thomas. Michigan State University, East Lansing, Michigan, August, 1966.

TABLE 11

GROUP CLUSTERS MEASURING "HITS" IN VALIDATION

Title	Cluster #	Component Group #	Total N	# of "Hits"	% of "Hits"
Business	1	8-9-10-11	75	24	32 %
Engineering-Physical Science	2	2-16-17-20-21	86	30	34.9%
Biological Science	3	1-19-22-27	67	20	29.8%
Arts & Letters-Social Science	4	3-4-5-6-7-12-23-24	175	91	52 %
Education-Home Economics-Social Work	5	13-14-15-18-26	143	18	12.5%
Psychology	6	25	21	0	0 %
	Totals	27 groups	567	183	32.2%

cedural manner. This validation discriminates according to group membership for each respondent using all ten discriminant functions at one time. In the first validation, each function predicted for each individual.

In computing the second validation, a procedure was followed which in effect was a discriminant classification operation. Through the Program Discras the raw scores of the individuals in the validation subsample, the pooled-samples D matix used as an estimate of common dispersion, the group means of all 27 groups, and the probabilities of an observation coming from each group produced a discriminant function value and group classification in rank order for each respondent. Thomas[13] explains the procedure this way.

> Consider m populations with multivariate normal densities p_1, p_2, ...p_m for a set of n variates. Suppose an observation X, where X is an ordered n-tuple whose elements are observed values of the n variates, must be assigned to one of the populations under the assumption that all misclassifications are equally costly. Anderson (1958) has shown that the expected cost of misclassification is minimized by assigning each observation to that population, say j, for which
>
> $$p_j(X) \quad p_k(X), \quad k= 1,2, \ldots m \text{ with } k = j.$$
>
> If a priori probabilities of membership in the various populations are not equal, let q_j be the a priori probability of membership in group j. Then the assignment procedure is to assign X to population j if
>
> $$q_j p_j(X) \quad q_k p_k(X) \quad \text{for all } k =1,2, \ldots m, \quad k = j.$$
>
> The MSU classification program bases assignment on the latter cirterion.

When compared to the curriculum in which the individuals

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[13]Memorandum from Stuart Thomas, CISSR, MSU, August, 1966.

presently have membership, Discras produced 137 direct "hits". This amounts to a prediction capability of 24 per cent.

SUMMARY

The results of the analysis failed to support the null hypothesis which said that there was no difference in self concept of ability and occupational interest, as entering freshmen, among groups of students classified by curriculum two years later. It is concluded that differences did exist among the groups.

Ten discriminant functions were found to be significant. The first three accounted for approximately seventy per cent of the total variance. The ten accounted for approximately ninety-eight per cent of the total variance. Statistical significance for all fifteen variables was also established. Although it might appear that some collapsing of variates might be possible, statistical significance disallowed such collapsing.

The discriminant functions were interpreted in two ways. First to be considered were the factor patterns with each function showing orthogonal characteristics. The second interpretation considered the group centroids. These were charted in three-dimensional space. Several groupings or clusters became evident from this charting.

The validation was carried out in two procedures also. The first validation was done through a comparison of discriminant scores. A set of discriminant scores was computed for an unclassified student on whom there were raw scores on

the variates, and he was classified into that group to whose mean discriminant score his discriminant score most closely came. The second validation involved all ten functions at one time and classified the individual respondent accordingly. This was done through a discriminant classification operation.

CHAPTER V

SUMMARY AND CONCLUSIONS

Summary

The over-all purpose of this study was to identify through the predictive use of certain elements of self concept, the academic field of concentration that a college student would select. The study was designed to differentiate between criterion groups on the basis of fifteen variables of self concept of ability and occupational interest. The variables were tested for statistical significance and significant difference for inclusion in the analysis. The following hypothesis was formulated and tested.

> It is possible to differentiate among groups of students classified by curriculum two years after initial entrance to college, on the basis of an identifiable pattern of self concept of ability and occupational interest as freshmen.

The population selected for this study consisted of the freshmen entering Michigan State University in the Fall of 1963. Of the 5,741 students classified as first-time freshmen, a restricted sample of 2,258 was chosen for the study. This selection was based on five factors which suited the purpose of the study. A validation subsample of 25% was obtained by the selection of every fourth student from the selected sample to be analyzed. The sample had been pre-

viously classified by curriculum grouping numbering 27 groups in all.

The instrument used was the Personal Information Inventory which contained the fifteen variables to be used as measures of self concept. This inventory was administered to all entering freshmen during the Summer Counseling Clinics of 1963. The members of the sample were assigned to groups according to their major two years later in the Fall of 1965.

Multiple discriminant analysis was chosen as the statistical method best suited to the problem of combining test scores and other data so as to maximize the difference between the groups and minimize the difference within each group. Through the separation of individuals who are known to belong to mutually exclusive groups, it is possible to determine the combinations of variables which will maximally discriminate among the different groups. It is also possible to observe the magnitude of the group differences and to classify future individuals into one of these groups on the basis of similar data. All computations for the multiple discriminant analysis was performed by the CDC 3600 computer at Michigan State University.

The analysis developed ten significant discriminant functions. These were interpreted by an examination of the factor patterns and also by plotting the group centroids for three of the functions in three-dimensional space. Weighted coefficients were conventionalized and applied to the raw scores of the validation subsample. Two separate procedures were performed here. The first validation produced a dis-

criminant score for each individual by each of the ten discriminant functions. The second validation afforded classification into 27 different groups in rank order with a discriminant function value for each. The second validation was a discriminant classification operation with all ten discriminant functions together performing the differentiation.

Conclusions

This study has demonstrated that the method used to predict for academic fields of concentration for incoming freshmen students is effective. This study has indicated within the limitations placed upon it that it is possible to use certain elements of self concept to classify new freshmen by curriculum groups with some degree of accuracy. The first validation produced 331 "hits", or 58.4 per cent of the validation subsample. To allow for possible duplication of "hits" an extension of the first validation was undertaken. This involved a rank ordering of group means for each of the first three discriminant functions and plotting in three-dimensional space. Clusters of groups were established in accordance with their closeness to each other in dimensional space. The validation subsample was tested so that each individual was identified for his likeness to a cluster. It was found that this method correctly predicted cluster placement 32.2 per cent of the total validation subsample.

The second validation, using all of the ten significant discriminant functions, produced 137 "hits", or approxi-

mately 24 per cent of the validation subsample. These were direct "hits" on specific groups and not clusters of groups.

Differentiating independently of the other functions, each of the first three discriminant functions appear to have significant discriminatory power. These functions account for about 70% of the total dispersion among groups. These functions are interpreted as artistic-social service (feminine) versus numerical-physical science (masculine), verbal-business detail versus biological science-mechanical-technical, and general (non-numerical) scholastic ability versus business detail-executive-managerial (practical) in nature, respectively. It is interesting to note that a factor not included in the measures was noted as being closely identified with a cluster of groups. This factor was sex. Female and male clusters of groups showed up significantly in the plotting. Education was the group scoring the most "hits", but in the final analysis the verbal cluster including arts and letters appeared to have the highest percentage of "hits".

Implications For Future Research

The study of classification of entering freshmen on the basis of self-concept variables leaves several questions unanswered.

1. Most important of the considerations for future research is the element of change. Norrell and Grater[1] are

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[1]Norrell, Gwen and Grater, Harry. "Interest Awareness as an Aspect of Self-Awareness," 7 Journal of Counseling Psychology (1960), 289-292.

very cognizant of change in self-awareness and self concept. Considerable effort could possibly be expended in a study to evaluate the effect of change of self concept upon the selection of an area of academic concentration.

2. The University College[2], Michigan State University, is aware of the many changes of major that take place each year. The Michigan State University Counseling Center also is greatly involved in this process. Future study could possibly reveal some type of cyclical change of major which eventually returns the student to the original field in which he entered. There might also be some relationship with the study suggested in number one.

3. Replication of this study with refined measures would probably improve the predictive value. Such consideration of the variables may also allow for prediction in a more refined classification such as academic major. Included in this possibility could be a consideration of the successful completion of a program of study. This could involve the same sample used in this study.

4. Some thought may be given to limiting the classifications by curriculum groups to some broader aspect such as education, medicine, law, business, and engineering to name a few. This clustering of groups may prove more resistant to change and provide better criteria for ultimate

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[2]Memo from University College, Michigan State University, East Lansing, Michigan. Major changes - Fall 1964-Fall 1965, North and South Campus. The memo lists 5535 changes of major, among and within ten colleges.

selection of an academic major.

5. It is felt that there may be considerable value in a study which mixes variables of an intellective and non-intellective kind for multivariate prediction. Literature indicates the lack of such studies for more than two or three groups with few exceptions. In those cases it was demonstrated that significantly better prediction is possible.

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APPENDIX A

The following is a sample of the academic structure of Michigan State University using one college only of a total of thirteen.

COLLEGE OF NATURAL SCIENCE - UNDERGRADUATE PROGRAM

Code	Curriculum	Code	Major
51	Natural Science	00	No Major - Special Program
52	Biochemistry	44	Biochemistry
54	General Science	48	Teaching Major Only
55	Biological Sciences	00	No Major
		43	Biological Sciences - Interdepartmental
		45	Botany and Plant Pathology
		47	Entomology
		49	Microbiology and Public Health
		51	Physiology
		53	Zoology
56	Physical Sciences	00	No Major
		56	Chemical Physics
		57	Chemistry
		59	Chemistry-Teaching
		61	Geology
		55	Physical Science - Interdepartmental
		65	Physics and Astronomy
57	Mathematics and Statistics	63	Mathematics
		69	Statistics
58	Nursing	41	Nursing
59	Pre-Professional	97	Pre-Dental
		99	Pre-Medical
		67	Pre-Optometry

APPENDIX B

GROUP MEANS FOR ALL TWENTY-SEVEN GROUPS AND FOR THE TOTAL GROUP ON THE MEASURES EMPLOYED IN THE STUDY

Group	Size	1	2	3	4	5	6	7
1	92	1.73	1.71	1.82	1.21	1.84	1.77	4.80
2	57	1.67	1.45	2.00	1.60	1.86	1.72	4.93
3	45	1.13	1.64	1.00	0.51	1.04	1.27	4.44
4	80	1.70	2.05	1.58	0.74	1.71	1.80	1.49
5	105	1.36	1.99	1.14	0.34	1.30	1.50	4.05
6	51	1.39	1.94	1.43	0.49	1.51	1.43	4.05
7	66	1.59	1.97	1.53	0.68	1.48	1.67	4.23
8	76	1.54	1.28	1.88	1.71	1.84	1.53	4.95
9	44	1.61	1.86	1.61	0.98	1.57	1.66	4.75
10	136	1.63	1.66	1.74	1.24	1.83	1.77	4.70
11	46	1.72	1.61	1.85	1.39	1.83	1.83	4.98
12	126	1.50	1.91	1.44	0.49	1.48	1.60	4.10
13	257	1.69	1.98	1.75	0.72	1.64	1.76	4.31
14	42	1.81	2.12	1.67	0.64	1.71	1.79	3.83
15	55	1.83	1.84	1.84	1.15	1.96	1.96	5.04
16	55	1.40	1.09	1.73	1.91	1.67	1.35	4.82
17	77	1.40	1.13	1.90	1.84	1.82	1.43	5.22
18	143	1.68	2.01	1.69	0.72	1.69	1.65	3.37
19	95	1.44	1.62	1.51	1.02	1.58	1.43	4.77
20	65	0.95	0.88	1.18	1.54	1.51	1.05	4.98
21	89	1.10	0.80	1.66	1.84	1.65	1.18	4.79
22	40	1.58	1.88	1.73	0.98	1.65	1.70	4.23
23	160	1.43	1.68	1.58	0.92	1.59	1.53	4.56
24	69	1.25	1.62	1.26	0.74	1.23	1.26	5.03
25	84	1.31	1.46	1.37	0.80	1.46	1.25	4.58
26	62	1.68	2.05	1.50	0.58	1.55	1.69	4.39
27	41	1.54	1.46	1.73	1.29	1.90	1.39	4.61
Total	2258	1.517	1.690	1.604	0.991	1.625	1.572	4.389

APPENDIX B (Continued)

Group	Size	8	9	10	11	12	13	14	15
1	92	3.83	3.14	2.60	4.88	5.00	4.81	5.09	4.86
2	57	2.25	2.30	3.81	4.91	4.77	4.84	5.11	4.33
3	45	4.07	4.20	5.22	3.80	4.80	4.16	3.29	5.00
4	80	4.39	4.24	4.74	3.64	5.31	4.98	4.93	5.09
5	105	4.58	4.50	4.99	2.80	4.73	4.28	3.36	4.87
6	51	4.53	4.76	4.83	2.45	4.67	4.65	3.29	5.24
7	66	4.38	4.30	5.00	3.05	4.55	4.08	3.94	4.97
8	76	3.49	4.71	4.91	4.62	2.14	4.74	4.68	4.29
9	44	4.95	4.64	4.95	4.00	3.98	4.25	5.11	3.05
10	136	4.01	4.64	4.78	4.23	3.81	4.24	4.56	3.78
11	46	3.78	4.48	4.50	5.00	4.26	3.32	4.76	3.63
12	126	4.44	4.60	5.18	4.07	4.71	4.29	3.02	4.63
13	257	4.48	4.00	4.97	1.17	4.24	4.50	4.73	5.01
14	42	4.40	3.55	4.76	1.90	4.71	4.81	4.38	5.05
15	55	4.36	3.93	4.16	2.40	4.09	4.85	4.45	4.73
16	55	1.15	4.75	3.96	4.87	4.80	4.93	4.98	5.02
17	77	1.27	4.43	4.19	4.81	4.88	5.31	5.08	4.53
18	143	4.74	4.04	4.80	2.48	4.52	4.34	4.74	4.93
19	95	3.60	1.66	4.75	4.25	5.37	4.99	4.96	5.17
20	65	1.66	3.22	4.40	4.71	5.38	4.80	5.15	5.17
21	89	1.69	4.44	4.80	3.92	4.33	4.93	4.75	4.98
22	40	4.30	1.40	4.73	3.55	4.88	5.00	4.68	5.08
23	160	4.18	4.06	4.76	3.63	4.76	4.04	3.81	4.57
24	69	4.36	4.26	4.86	4.06	5.04	3.72	2.86	4.72
25	84	3.44	3.58	4.85	3.52	5.15	4.51	3.93	5.10
26	62	4.76	3.13	4.77	2.29	4.81	4.90	4.68	5.15
27	41	3.73	1.27	3.41	4.76	5.12	5.22	5.05	4.98
Total	2258	3.882	3.951	4.649	3.541	4.581	4.530	4.391	4.751

APPENDIX C

STANDARD DEVIATIONS OF THE MEASURES EMPLOYED IN THE STUDY FOR ALL TWENTY-SEVEN GROUPS AND FOR THE TOTAL GROUP

Group	Size	1	2	3	4	5	6	7
1	92	0.52	0.62	0.61	0.87	0.56	0.77	1.21
2	57	0.48	0.54	0.63	0.70	0.55	0.65	1.28
3	45	0.69	0.74	0.64	0.79	0.67	0.72	1.77
4	80	0.54	0.83	0.59	0.87	0.66	0.62	1.10
5	105	0.62	0.79	0.70	0.66	0.77	0.72	1.89
6	51	0.53	0.61	0.57	0.78	0.73	0.61	1.91
7	66	0.50	0.78	0.66	0.88	0.75	0.66	1.43
8	76	0.60	0.60	0.54	0.61	0.67	0.62	1.04
9	44	0.49	0.67	0.62	0.93	0.66	0.68	1.46
10	136	0.50	0.66	0.58	0.86	0.63	0.80	1.05
11	46	0.46	0.61	0.60	0.86	0.57	0.61	1.09
12	126	0.55	0.70	0.60	0.79	0.63	0.67	2.07
13	257	0.49	0.68	0.58	0.87	0.60	0.69	1.86
14	42	0.45	0.50	0.61	0.88	0.67	0.61	1.72
15	55	0.51	0.60	0.57	0.83	0.58	0.77	1.60
16	55	0.76	0.65	0.62	0.29	0.77	0.67	1.29
17	77	0.63	0.57	0.64	0.40	0.66	0.57	1.33
18	143	0.54	0.70	0.55	0.88	0.59	0.64	2.09
19	95	0.56	0.62	0.68	0.85	0.68	0.65	1.57
20	65	0.76	0.78	0.78	0.75	0.77	0.69	1.05
21	89	0.68	0.62	0.82	0.45	0.62	0.63	1.50
22	40	0.55	0.69	0.60	0.97	0.53	0.69	1.42
23	160	0.56	0.74	0.70	0.88	0.68	0.67	1.36
24	69	0.69	0.89	0.80	0.89	0.77	0.72	1.16
25	84	0.64	0.74	0.71	0.86	0.72	0.69	1.37
26	62	0.54	0.73	0.67	0.82	0.62	0.64	1.72
27	41	0.55	0.71	0.55	0.84	0.49	0.59	1.20
Total	2258	0.600	0.770	0.675	0.912	0.673	0.707	1.702

APPENDIX C (Continued)

Group	Size	8	9	10	11	12	13	14	15
1	92	2.13	1.88	1.87	1.95	1.55	1.61	1.16	1.96
2	57	2.20	1.89	1.76	1.57	1.90	1.53	1.29	2.02
3	45	1.85	1.96	0.93	2.03	1.78	1.81	2.29	1.80
4	80	1.63	1.57	1.57	1.95	1.43	1.53	1.66	1.26
5	105	1.38	1.90	0.83	2.11	1.61	1.71	2.17	1.29
6	51	1.49	1.67	1.07	1.99	1.65	1.60	2.18	1.37
7	66	1.81	1.61	1.15	2.51	1.41	1.81	1.99	1.84
8	76	2.20	1.45	1.50	1.83	1.72	1.60	1.35	2.07
9	44	1.66	1.99	1.58	1.82	1.72	2.34	1.97	2.47
10	136	1.99	1.56	1.67	2.01	2.32	1.94	1.76	2.17
11	46	2.06	1.62	1.66	2.04	2.07	2.10	1.78	2.06
12	126	1.49	1.75	1.17	2.32	1.52	2.03	2.15	1.78
13	257	1.13	1.80	0.86	1.57	1.85	1.60	1.63	1.03
14	42	1.43	1.95	1.23	1.72	1.77	1.47	1.59	1.03
15	55	1.47	1.90	1.62	1.95	1.71	1.51	1.54	1.60
16	55	0.62	1.70	2.00	1.36	2.03	1.35	0.88	2.15
17	77	1.03	2.14	2.27	1.43	1.78	1.22	1.05	2.07
18	143	1.13	1.73	0.97	1.73	1.61	1.75	1.52	1.42
19	95	1.93	1.45	2.05	1.99	1.49	1.28	1.56	1.56
20	65	1.68	1.82	2.12	1.55	1.61	1.08	1.73	1.69
21	89	1.55	1.57	1.31	2.06	1.51	1.32	1.49	1.62
22	40	1.22	0.98	1.28	2.05	1.44	0.80	1.35	0.47
23	160	1.82	1.87	1.35	2.20	1.65	1.93	2.09	1.73
24	69	1.76	1.56	1.25	2.32	1.62	2.26	2.12	2.06
25	84	1.92	1.82	1.52	2.50	1.54	1.92	2.16	1.86
26	62	1.22	1.87	1.12	2.23	1.63	1.72	1.80	1.23
27	41	1.87	0.59	1.64	1.50	1.14	1.35	0.80	1.46
Total	2258	1.937	1.919	1.541	2.213	1.814	1.734	1.860	1.72

APPENDIX D

CONVENTIONALIZED DISCRIMINANT COEFFICIENTS CORRESPONDING TO THE TEN SIGNIFICANT DISCRIMINANT FUNCTIONS

Variable	V1	V2	V3	V4	V5
1	- .445800	.341400	.600000	.037800	- .269400
2	- .420420	.000000	.038500	.013860	- .685300
3	.095175	- .070200	.536625	- .137025	.492075
4	.912000	.031008	.525312	- .216144	- .067488
5	.324386	.232185	.067973	- .211322	- .168923
6	- .086254	- .002121	.327341	.149884	- .482881
7	.869954	- .239982	.217856	1.702000	1.473932
8	-1.578655	.162708	.846469	.199411	- .371904
9	.316635	-1.919000	.328149	- .863550	- .805980
10	- .539350	- .930764	-.340561	- .265052	.608695
11	1.290179	- .312033	-.013278	1.168464	-2.213000
12	- .009070	.807230	-.912442	- .058048	- .881604
13	.065892	.407490	.088434	- .483786	.029478
14	.323640	.850020	.864900	- .645420	.048360
15	- .230622	.391884	-.542742	- .435234	.265302

APPENDIX D (Continued)

Variable	V6	V7	V8	V9	V10
1	- .252600	- .039000	.114000	-.128400	-.148800
2	- .199430	.770000	.069300	-.564410	-.114730
3	- .497475	- .146475	.675000	.675000	-.470475
4	.763344	.230736	-.215232	-.108000	.060192
5	.242953	- .496001	-.142003	.086817	.673000
6	- .296233	.485002	.074235	-.225533	.337239
7	- .985458	.611018	.011918	-.319976	-.042550
8	.596596	- .466817	-.304109	.123968	-.096850
9	-1.182104	.211090	-.172710	-.180386	-.115140
10	1.541000	1.037093	.329774	-.160264	.009246
11	.725864	-1.197233	.137206	-.250069	-.225726
12	- .912442	1.371384	.068932	.204982	.072560
13	- .036414	- .480318	.149124	-.766428	.019074
14	.303180	1.233180	-.392460	-.172980	-.275280
15	- .412692	- .939828	.034680	-.142188	-.244494

APPENDIX E

GROUP CENTROIDS

Group #	Discriminant Functions 1	2	3
1	1.138	1.620	3.305
2	2.115	.136	3.194
3	- .310	- .981	1.517
4	- 1.109	.580	2.596
5	- 1.080	- .805	1.974
6	- .973	- .763	2.141
7	- .683	- .518	2.571
8	1.460	- 1.415	3.912
9	- .002	- .864	3.764
10	.651	- .909	3.510
11	1.173	- .748	3.573
12	- .547	- 1.142	2.184
13	- 1.184	.104	3.183
14	- 1.216	.631	2.808
15	- .129	.322	3.557
16	2.820	- .317	2.454
17	2.842	- .139	2.669
18	- 1.118	.213	2.981
19	.459	1.773	2.158
20	2.367	.608	1.542
21	2.264	- .620	2.286
22	- .377	1.915	2.600
23	.024	- .435	2.485
24	- .003	- 1.031	1.804
25	.255	.045	1.798
26	- 1.121	.898	2.723
27	1.006	2.587	2.694