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ABSTRACT

The monograph consists of seven related papers written during the past five years focusing on measuring the vocational interests of young adults. Its stated purpose is to provide both a conceptual framework and a practical foundation for interpreting the world of work to students in terms of their own characteristics and vocational interests. The papers describe one approach to relating interests and occupations based on the circular configuration of interests and occupations proposed by John L. Holland. This approach labels occupational categories as: realistic, intellectual, artistic, social, enterprising, and conventional. The papers offered are: (1) An Empirical Occupational Classification Derived from a Theory of Personality and Intended for Practice and Research, (2) An Analysis of Spatial Configuration, (3) A Spatial Configuration of Occupations, (4) An Analysis of the Structure of Vocational Interests, (5) On Measuring the Vocational Interests of Women, (6) The Vocational Interests of Students in Career-Oriented Educational Programs, and (7) Relating High School Interests to Occupations Five Years After High School. Collaborating authors are John L. Holland, Douglas R. Whitney, Nancy S. Cole, James M. Richards, Jr., James W. L. Cole, Gary R. Hanson, Dale J. Prediger, and John D. Roth. A 61-item list of American College Testing (ACT) publications concludes the document. (MW)

MONOGRAPH ELEVEN:

# THE VOCATIONAL INTERESTS



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# PREFACE

The focus of this monograph is on measuring the vocational interests of young adults. Young men and women between the ages of 17 and 25 are of special interest because during this period of their lives they are making critical decisions about their education and careers. Providing information to students to better understand the world of work and their place in it is an important role for counselors and educators. The purpose of this monograph is to collect a series of related papers which provide both a conceptual framework and a practical foundation for interpreting the world of work to students in terms of their own characteristics/vocational interests.

Many methods have been used to relate the domain of vocational interests to the domain of occupations. All the methods have certain similarities and compatibilities. Choices among them must be made on the basis of their usefulness in various applications. The papers composing this monograph describe one approach to relating interests and occupations based on the circular configuration of interests and occupations proposed by Roe and Holland. No attempt has been made here to directly compare the merits of this approach with other alternatives. However, the monograph expresses our bias that this circular framework provides a valuable, practically-useful method for assisting young adults in their important career decisions.

By bringing these various studies on the vocational interests of young adults together, we hope that their career decisions may be better ones. Application of the circular configuration as a guide for career exploration and guidance is generally helpful, we feel. If after reading this monograph counselors are better able to communicate information to students concerning their vocational interests as they relate to the world of work, our efforts will have been worthwhile.

Leo A. Munday, *Vice President*
*Research and Development Division*

Iowa City, Iowa
December 1973

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# INTRODUCTION

Although the papers in the monograph have been written in the past 5 years, they are based on a much older research foundation. Thus, as an introduction, we first briefly review the major studies which led to the conceptualization of interests and occupations in a circular configuration.

Evidence has accumulated over the last several years which suggests that a basic set of vocational interest categories are common to a number of occupational classification schemes and interest inventories. Roe (1956) proposed a two-dimensional classification scheme in which occupations were organized into eight groups and five levels of responsibility and skill. The eight groups were Technology, Outdoor, Science, Arts and Entertainment, General Cultural, Service, Business Contact, and Organization; and each occupation could potentially be classified into one group along with other occupations involving similar vocational interests.

Super (1957) proposed occupational categories that were very similar in description and name to those suggested by Roe: Technical or Material, Scientific, Musical and Artistic, Humanistic or Social Welfare, Business Contact, and Business Detail. In addition, Holland (1966) proposed grouping occupations into six basic categories which again closely corresponded in description to those of Roe and Super.

Holland's categories were labeled Realistic, Intellectual, Artistic, Social, Enterprising, and Conventional and were supposed to represent not only the primary categories of vocational interest but many personality characteristics as well. The Realistic category represents masculine, technical interests while Intellectual interests are primarily scientific and asocial. Artistic interests include music, writing, and art as well as other forms of individual expression. The Social category encompasses interest in working with people and serving people. The Enterprising type is ambitious, business-oriented, and social. Finally, Conventional interests are business-related, systematic, and structured.

Several empirical approaches to the examination of vocational interests led to similar classes of occupations. In a number of factor analytic studies summarized by Super and Crites (1962) interest factors similar to the categories discussed above were reported. Further similarities are found in the families of scales of the Strong Vocational Interest Blank (SVIB) discussed by Strong (1943) and Darley and Hagenah (1955). And when the numerous occupational scales of the SVIB were combined (using scale intercorrelations) into the somewhat fewer Basic scales (Campbell, Borgen, Eastes, Johansson, and Peterson, 1967) very similar classes of occupations emerge.

These similar classes of occupations and occupational interests suggested by various writers had been used primarily as discrete and independent categories. However, Roe (1956) noted that categories adjacent in her ordered list were related, and Roe and Klos (1969) formalized this suggestion by describing the interest categories as a circular ordering in which classes adjacent in the circle were most closely related while those most widely separated were the least related. In the ordering of the Roe groups listed above, the circle is completed by placing the last group, Organization, adjacent to the first, Technology.

Drawing on this background of research and growing concensus, Holland began reexamining his six categories (as operationalized in six scales of his Vocational Preference Inventory) for evidence of a similar circular arrangement. The first paper in this monograph reports the results of that reexamination in which a circular (or hexagonal) arrangement of scales was identified and its possible uses for organizing occupations for counseling and exploration noted. This paper then served as a stimulus for further research studies to explore both the generality of this circular structure and its usefulness as an organizational or classificational structure for occupations. The remaining papers in this monograph are the direct results of this exploration.

In "An Empirical Occupational Classification Derived from a Theory of Personality and Intended for Practice and Research," Holland and his colleagues first identified the circular or hexagonal relationship of the six Vocational Preference Inventory (VPI) scales. Occupational choice groups of college students were then classified into the six major categories according to the highest VPI scale score while within-category distinctions were made on second and third highest VPI scores.

The desire to examine and summarize the interrelationships of interest scales led to the development of methodology to statistically provide the required summary of interrelationships. In the paper, "An Analysis of Spatial Configuration," Cole and Cole described the methodology on which most of the subsequent papers in the monograph are based.

From concern with the interrelationship of Vocational Preference Inventory scales, the interest shifted to a more direct use of the circular structure to provide an occupational classification or map. Thus, Cole, Whitney, and

Holland applied the spatial configuration methodology to obtain an occupational configuration in "A Spatial Configuration of Occupations" and to suggest an alternative to the method of occupational classification suggested by Holland, Whitney, Cole, and Richards in the first paper in this series.

From the initial analyses solely on Holland's interest inventory, Cole and Hanson broadened the concern to other commonly used inventories. In "An Analysis of the Structure of Vocational Interests," they reported circular configurations of interest scales similar to Holland's in each inventory investigated for a variety of samples of men. Thus, these analyses empirically illustrated the pervasiveness of the circular structure in interest measurement.

Cole expanded the analyses of circular interest structure to women in "On Measuring the Vocational Interests of Women." The results identified the same circular configuration of interests in data on women as had been found for men. In addition, occupational maps for women were very similar to those for men, indicating the possible usefulness of the circular interest structure for exploration by women of the full spectrum of occupations.

Hanson and Prediger provided occupational choice maps for a new segment of youth, those entering vocational-technical educational programs, and again found the now-standard circular configuration. In addition, in "The Vocational Interests of Students in Career-Oriented Educational Programs," the discrimination of occupational choice groups on the basis of the general ACT Vocational Interest Profile scales was reported.

In the final paper in the monograph, Roth provides the jump from occupational choice groups based on student data to those based on employed young adults. In "Relating High School Interests to Occupations Five Years after High School," interest inventory data from Project Talent on high school students provide the basis for occupational maps based on employment 5 years later. Thus, the circular configuration of interests of high school students is linked to a configuration of occupations when those students reached employment.

# AN EMPIRICAL OCCUPATIONAL CLASSIFICATION DERIVED FROM A THEORY OF PERSONALITY AND INTENDED FOR PRACTICE AND RESEARCH

*John L. Holland, Douglas R. Whitney, Nancy S. Cole, and James M. Richards, Jr.*

The origin, development, verification, and revision of an occupational classification is presented. The classification organizes occupations according to their degree of psychological "relatedness" following Holland's theory of personality. Because of its theoretical simplicity and empirical base, the classification has many potential practical applications for vocational guidance, industrial personnel work, and research in education, psychology, and sociology.

This report presents a revision of the occupational classification scheme first proposed and tested in an earlier study (Holland, 1966b). The many desirable features of this revised classification enhance its potential value both for research and for vocational guidance and personnel work.

## The Original Classification

In 1959, Holland proposed an a priori occupational classification of six categories. From 1959 to 1965, this classification was used in several theoretical studies, but it was neither *directly* tested for its value as a classification system nor explicitly defined for clear and easy use. Later Holland

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We are indebted to the following people for their constructive assistance: Linda R. Shevel, Leonard L. Baird, Charles F. Elton, Evelyn A. Bollinger, and Janis S. Walton.

(1966b) defined the major categories of the classification—Realistic, Intellectual, Artistic, Social, Enterprising, and Conventional—in terms of the six Vocational Preference Inventory (VPI) scales having the same names. The assumption that occupational titles in the VPI scales define comparable categories in the classification made an explicit reconstruction of the classification possible.

To obtain the first empirical version of the classification (Holland, 1966a), a profile of VPI means was calculated for students planning to enter each occupation. An occupation's coded profile (highest scale mean first, next highest scale second, etc.) defined an occupation's place in the classification. For example, an occupation with a code of RIES was placed in the major category—Realistic. The remainder of the code indicated that occupation's particular subgroup within its major category. The application of this procedure to the VPI data for 12,432 college freshmen in 31 institutions (Abe et al., 1965) produced separate classifications for men and women. The classification for men included all six major VPI categories (Realistic, Intellectual, Artistic, Social, Enterprising, and Conventional), each with one or more subgroups. The VPI data for women yielded only four major groups (Intellectual, Artistic, Social, Conventional) with a number of subgroups within each of the major categories.

This first classification was tested for its usefulness in a series of studies. In the first study, Holland (1966a) obtained several favorable results: the classification developed from one sample (N=12,432 college students) produced expected results when applied to another sample (N=10,646 college students). When students were grouped into six categories according to their occupational choice, their highest mean score occurred on the corresponding VPI scale; that is, students who chose occupations previously classified as "Realistic" had the Realistic scale of the VPI as their highest mean score. Also, their mean on that scale was higher than the Realistic mean of any other occupational group. Without exception, similar findings held for the remaining occupational groups of men and women.

In a second study, Holland (1968b) demonstrated that individual profiles using one, two, and three scales could be interpreted according to his theory of personality types. For example, Realistic peaks were associated with technical competencies and mechanical ability; Intellectual peaks were associated with scientific competencies, mathematical ability, etc. Students with the same high point scale can still be distinguished by their second highest VPI scale. And students whose first two highest scales were the same, can still be distinguished by their third highest scale. For these three levels of predictive difficulty, 6[illegible]-84% of the theoretical predictions of peaks for students with different characteristics were correct for large samples of men and women.

In a third study, Holland and Whitney (1968) applied the classification to longitudinal data and obtained unusually efficient predictions of vocational aspirations over an 8 to 12 month interval. For example, 79% of the men and 93% of the women indicated successive vocational choices that were described as related or lawful rather than random. In this later study, a comparison of Holland's (1966a) and Roe's (1956) classification systems suggested that the original Holland classification appeared to be somewhat more efficient for prediction. (At the same time, Holland's scheme may have enjoyed some advantages because it was developed from earlier data using the same sample of college students.)

In an unpublished reanalysis of 4-year longitudinal data from a national sample of college students (Astin & Panos, 1968), we applied the classification scheme and obtained closer relationships between successive vocational choices than had the original authors. In several other unpublished analyses, we again found higher relationships between successive occupational choices (Sharp & Krasnegor, 1966; Davis, 1965; and others). Generally, these gains in predictive efficiency were large because most informal classifications create categories consisting of occupations known to be psychologically diverse.

Finally, Richards (in Holland, 1968a) performed diagonal factor analyses to determine whether or not each VPI scale measures a dimension independent of what the scales have in common. The results of separate analyses for large samples (3,771 men and 3,492 women) clearly demonstrate that each scale does measure something different from the others; or, there are at least six kinds of people. There may be more, but not fewer.

In short, the original classification produces efficient predictions, contains a set of concepts each with some unique variance, and provides explicit interpretations of class membership.

## The Revised Classification

The following is the latest revision of Holland's (1966a) classification. For this revision, Vocational Preference Inventory (VPI) data for a large sample of 2-year college students (12,345 men and 7,968 women) were added to the data obtained in 1966 for 4-year college students. Data from some samples of employed adults were also added to the classification. These additions made the classification more comprehensive and reliable.

In this revision, occupations were assigned to classes exactly as before; that is, coded mean VPI scores of all students aspiring to an occupation indicated an occupation's place in the classification.

In the first classification, the arrangement of subgroups within a major class had no special meaning. In the revision, however, the major classes and subclasses were arranged according to the following hexagonal model (see Figure 1). The hexagonal model was discovered somewhat accidentally when we noticed that an intercorrelational matrix for the VPI scales used in the classification could be approximated by the distances within the hexagon. Subsequent examination of correlation matrices for nine different samples revealed that the hexagonal model provided satisfactory approximations.

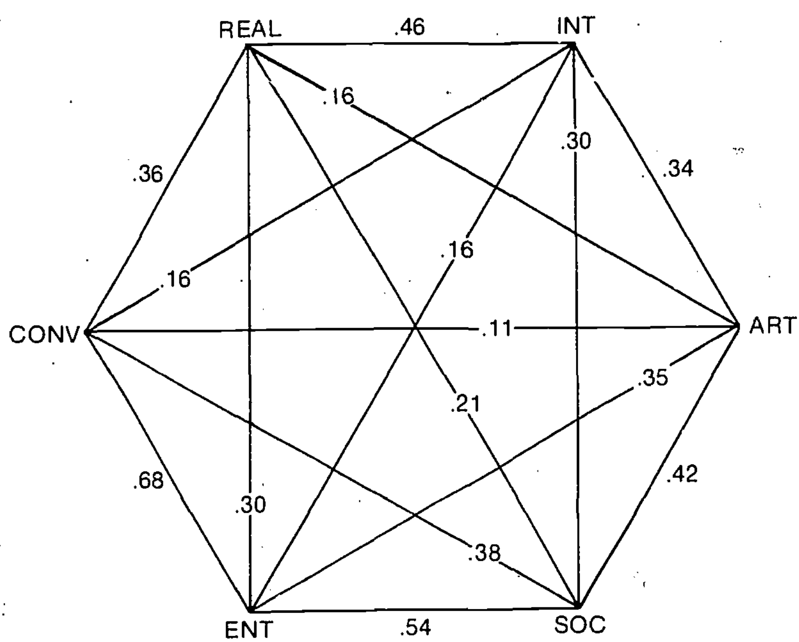


**Fig. 1.** A hexagonal model for interpreting inter- and intra-class relationships.

## The Revised Occupational Classification

In the following classification note these abbreviations. Under the heading "sample," "2" indicates 2-year college students, "4" indicates 4-year college students, and "E" indicates a sample of employed adults. Underlining indicates "tied codes" or identical average scores on the Vocational Preference Inventory.

If 2- and 4-year samples were obtained for an occupation, they are placed together. Note that the codes obtained from different samples are usually similar. The placement of occupations with different codes (2-year versus 4-year) was sometimes an ambiguous decision.

A mathematical verification of the hexagonal configuration was obtained by using factor analysis to locate the six VPI scales in a three dimensional space.[1] Since all six variables had high positive loadings on the first factor, which represents an overall checking rate on the VPI (one kind of response set), they lay very nearly in a plane approximately perpendicular to the first factor. Fitting a plane to minimize the deviation of the points from it and projecting the six points onto this "best-fitting" plane resulted in the configurations for men in Figure 2 and for women in Figure 3.

The data in the illustrative hexagon is for a 10% sample of 1,234 out of 12,345 male 2-year college students in 65 colleges. A sample of 796 out of 7,968 females in the same colleges produces similar results. This simple

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[1]From the correlation matrix of the six scale scores given in the GP Manual (Holland, 1968a, pp. 35, 36) principal component analyses were computed separately for men and women. The first three dimensions or factors accounted for 78% and 76% of the trace respectively, and the succeeding steps used only these three dimensions.

All six scales had large positive loadings on the first factor. Thus, in the three-space defined by the three factors, the six points fell very nearly in a plane. By using the (6 x 3) factor loading matrix to locate the six points in this three-space, the smallest characteristic vector of the covariance matrix of the three factors is in the direction which minimizes the deviation from a plane fitting the six points. The two largest characteristic vectors correspondingly define this "best fitting" plane. When the points in three-space (the six VPI scales) are projected onto this plane, the result is a two-dimensional representation of the six points which is given in Figure 2 for men and Figure 3 for women.

The excellent fit of the points in the three-space to the plane is clear from the fact that the third characteristic root (showing deviation from the plane) accounted for only .2% and 1.1% of the trace for men and women, respectively. Thus the principal variation ignored in these analyses is that involved in the fourth, fifth, and sixth factors of the original correlation matrix, and even this, as noted, is a minor source of variation.

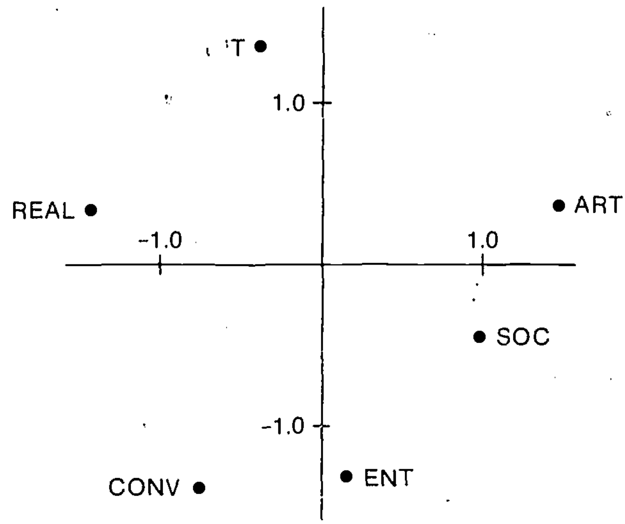


**Fig. 2.** Configuration of six VPI scales in a "best-fitting" plane from analysis of the correlation matrix for men.

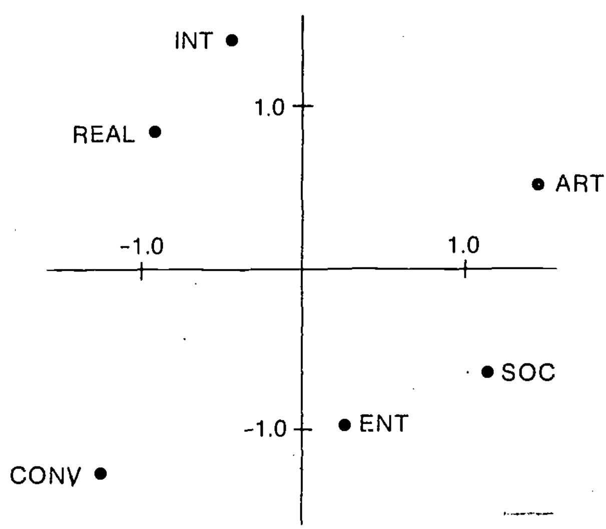


**Fig. 3.** Configuration of six VPI scales in a "best-fitting" plane from analysis of the correlation matrix for women.

## REALISTIC CLASS (MEN)

| *Sample* | *Occupation* | *Code* | *N* |
|---|---|---|---|
| 4 | Architect | RIAE | 83 |
| 2 | Architectural Draftsman | RIAE | 237 |
| 2 | Forester | RISE | 151 |
| 4 | Forester | RISE | 105 |
| 4 | Geographer | RISE | 12 |
| 4 | Industrial Arts Teacher | RISE | 50 |
| 2 | Industrial Arts Teacher | (RSIE) | 39 |
| 4 | Trades & Industrial Teacher | RISE | 27 |
| 2 | Draftsman | RIEA | 256 |
| 2 | Aviation Worker | RIES | 149 |
| 2 | Farmer | RIES | 190 |
| 4 | Farmer | RIES | 61 |
| 2 | Architectural & Civil Eng. Technician | RIEC | 265 |
| 4 | Civil Engineering | RIEC | 185 |
| 2 | Electrical Worker | RIEC | 604 |
| 2 | Electronic Engineering Technician | RIEC | 163 |
| 2 | Engineer | RIEC | 246 |
| 2 | Industrial Eng. Technician | RIEC | 106 |
| 4 | Industrial Engineer | RIEC | 37 |
| 2 | Mechanical Eng. Technician | RIEC | 398 |
| 4 | Mechanical Engineer | RIEC | 152 |
| 2 | Metal/Machine Worker | RIEC | 102 |
| 4 | Agronomist | REIS | 166 |
| 2 | Construction Worker | REIS | 103 |
| 2 | Air Conditioning Eng. Technician | REIC | 55 |
| 2 | Mechanics Worker | REIC | 248 |
| 2 | Printer | RESI | 66 |

## INTELLECTUAL CLASS (MEN)

| Sample | Occupation | Code | N |
|---|---|---|---|
| 4 | Anthropologist | IASR | 12 |
| 4 | Physical Therapist | IASR | 9 |
| 4 | Physician | ISAE | 354 |
| 2 | Physician | (ISAR) | 101 |
| 4 | Biological Scientist | ISRA | 36 |
| 4 | Biologist | ISRE | 55 |
| 4 | Natural Science Teacher | ISRE | 86 |
| 4 | Physical Scientist | ISRE | 5 |
| 4 | Mathematics Teacher | ISRC | 138 |
| 4 | Home Economist | IESA | 5 |
| 4 | Physiologist | IESA | 12 |
| a | Pharmacist | IESR | 374 |
| 4 | Pharmacist | IESR | 51 |
| 2 | Pharmacist | (IERS) | 48 |
| 4 | Dentist | IERS | 120 |
| 2 | Dentist | (ISER) | 67 |
| 4 | Astronomer | IRAS | 14 |
| 4 | Chemist | IRAS | 87 |
| 4 | Geologist | IRASE | 19 |
| 4 | Physicist | IRAS | 61 |
| E | Engineer/Technician | IRAS | 58 |
| 4 | Engineering Scientist | IRAC | 44 |
| 4 | Biochemist | IRSA | 15 |
| 2 | Biological Scientist | IRSA | 136 |
| 4 | Botanist | IRSA | 12 |
| 2 | Medical Technologist | IRSA | 53 |
| 4 | Medical Technologist | IRSA | 9 |
| 4 | Oceanographer | IRSA | 9 |
| 2 | Physical Scientist | IRSA | 54 |

[Continued]

**Intellectual Class (Men)** [*Continued*]

| *Sample* | *Occupation* | *Code* | *N* |
|---|---|---|---|
| 4 | Zoologist | IRSA | 33 |
| 2 | Optometrist | IRSE | 20 |
| 4 | Veterinarian | IRSE | 120 |
| 2 | Veterinarian | IRSE | 76 |
| 2 | X-Ray Technician | IRSE | 39 |
| 4 | Chemical Engineer | IREA | 94 |
| 4 | Electrical Engineer | IREA | 259 |
| 2 | Metal Eng. Technician | IREA | 19 |
| 2 | Aerospace Eng. Technician | IRES | 188 |
| 2 | Chemical Eng. Technician | IRES | 80 |
| 4 | Military Officer | IRES | 80 |
| 4 | Aeronautical Engineer | IREC | 77 |
| 4 | Metallurgical Engineer | IREC | 14 |
| 4 | Mathematician/Statistician | IRCE | 80 |
| 2 | Mathematician | (IRSE) | 74 |

[a]Students and faculty from three schools of pharmacy.

geometric model arranges student occupational aspirations according to their psychological relatedness, thereby making the classification more useful for vocational guidance and research in careers. The hexagonal model arranges the main categories in the following order—Realistic, Intellectual, Artistic, Social, Enterprising, and Conventional (proceeding around the hexagon in a clockwise direction)—so that adjacent main categories are most closely related. (See the hexagon on page 8.) In general, close relationships are represented by short distances on the hexagon.

We can apply the same principle of arrangement to the subgroups within a major category by observing the following rules. Within a major category, arrange the subgroups so that the second code letters follow in clockwise order starting from the major category's first code. In the same manner,

**ARTISTIC CLASS (MEN)**

| *Sample* | *Occupation* | *Code* | *N* |
|---|---|---|---|
| 4 | Speech Teacher | ASER | 10 |
| 4 | Actor-Drama Coach | ASEI | 19 |
| 2 | Cosmetologist | ASEI | 5 |
| 4 | English Teacher | ASEI | 67 |
| 2 | Speech/Drama Teacher | ASEI | 40 |
| 4 | Art Teacher | ASIE | 29 |
| 4 | Music Teacher | ASIE | 63 |
| 2 | Musician | ASIE | 86 |
| 4 | Musician | (ASEI) | 41 |
| 4 | Philosopher | ASIE | 10 |
| 4 | Writer | ASIE | 42 |
| E | Advertising Man | AESI | 46 |
| 4 | Journalist | AESI | 58 |
| 2 | Journalist | (ASEI) | 62 |
| 2 | Photographer | ARIS | 100 |
| 4 | Foreign Language Interpreter | AISE | 6 |
| 4 | Literature Teacher | AISE | 10 |
| 2 | Artist | AIRS | 179 |
| 4 | Artist | (AISE) | 45 |

arrange subgroups whose first two letters are identical by the third (and finally, fourth) letter. For example, in the Realistic category, RI (Realistic-Intellectual) subgroups precede RA (Realistic-Artistic) subgroups, RAE (Realistic-Artistic-Enterprising) precedes RAC (Realistic-Artistic-Conventional), and RIAS (Realistic-Intellectual-Artistic-Social) precedes RIAC (Realistic-Intellectual-Artistic-Conventional). The application of this simple rule places the first subgroup in a main category close to the major category on the right, places the middle subgroups at a neutral or distant point, and places the last subgroup closest to the major category on the left.

The practical outcomes of rearranging the main categories and subcategories following the hexagonal model are largely unclear and

## SOCIAL CLASS (MEN)

| Sample | Occupation | Code | N |
|---|---|---|---|
| 2 | Physical Ed. Teacher | SERI | 274 |
| 4 | Physical Ed. Teacher | (SRIE) | 272 |
| | | | |
| E | Counselor | SEIA | 58 |
| 4 | Counselor | (SEAI) | 36 |
| 4 | Educational Psychology | SEIA | 9 |
| 4 | Historian | SEIA | 57 |
| 2 | Historian | SEIA | 123 |
| 4 | History Teacher | SEIA | 202 |
| E | Junior College Administrator | SEIA | 16 |
| | | | |
| 4 | Foreign Service Officer | SEAI | 35 |
| 4 | Industrial Psychologist | SEAI | 17 |
| 2 | Sociologist | SEAI | 57 |
| 4 | Sociologist | SEAI | 15 |
| 2 | Teacher | SEAI | 739 |
| | | | |
| 2 | Policeman | SREI | 318 |
| | | | |
| 4 | Librarian | SRIA | 6 |
| 2 | Librarian | (SIAR) | 5 |
| 4 | Special Ed. Teacher | SRIA | 8 |
| | | | |
| 2 | Dental Technologist | SIER | 8 |
| 4 | Elementary Teacher | SIER | 117 |
| 2 | Social Scientist | SIER | 50 |
| | | | |
| 4 | Experimental Psychologist | SIEA | 23 |
| 2 | Foreign Language Interpreter | SIEA | 21 |
| 4 | Social Worker | SIEA | 19 |
| | | | |
| 2 | Mortician | SIRE | 13 |
| | | | |
| 2 | Therapist | SIRA | 23 |
| | | | |
| 2 | Nurse | SIAE | 34 |
| | | | |
| 2 | English Teacher | SAER | 39 |
| 4 | Foreign Language Teacher | SAER | 17 |

[Continued]

**Social Class (Men)** [*Continued*]

| *Sample* | *Occupation* | *Code* | *N* |
|---|---|---|---|
| 2 | Social Service Worker | SAEI | 76 |
| E | Clergyman | SAIE | 32 |
| 4 | Clergyman | SAIE | 77 |
| 2 | Clergyman | (SAER) | 47 |
| 4 | Clinical Psychologist | SAIE | 42 |
| 2 | Psychologist | SAIE | 137 |

untested at this time. A review of this arrangement does suggest that the hexagonal model provides a more psychologically based arrangement; that is, subgroups of occupations that seem to go together—because of their codes and therefore their assumed psychological similarity—appear to be placed close to each other more frequently than in the original classification. The value of the hexagonal arrangement for the main classes is clearly supported by an earlier longitudinal study (Holland & Whitney, 1968). In that study, if students changed their occupational preference, the majority of such changes were accomplished by movement to an adjacent major category where "adjacent" is defined by the hexagonal model. Concretely, a change from a Realistic choice to an Intellectual or Conventional choice is a change to an "adjacent" category. More investigation will determine the value of the hexagonal arrangement for subclasses although the arrangement implies some interesting hypotheses about the nature of relationships among similar occupations.

To summarize, we now assume that the revised classification has the following desirable characteristics: (a) an explicit theory for interpreting class membership, for organizing information about occupations, and for revising the classification, (b) mutually exclusive classes, (c) efficient forecasting ability for several purposes, and (d) provision for explicit extension to unclassified occupations by the application of a single, empirical technique. Since the VPI scales are measures of personality as well as interests, and since people with similar interests have similar personalities, we assume that the occupational classification organizes similar personalities in some practical and scientific ways.

At the same time, the revised classification still has some deficiencies. They include (a) a lack of comprehensiveness, despite classifying all the common

## ENTERPRISING CLASS (MEN)

| *Sample* | *Occupation* | *Code* | *N* |
|---|---|---|---|
| 4 | Buyer | ECRI | 16 |
| 2 | Clothing Technologist | ECRS | 9 |
| 2 | Real Estate Agent | ECRS | 43 |
| 2 | Economist | ECSR | 45 |
| 4 | Economist | (ECIS) | 14 |
| 4 | Manager/Administrator | ECSR | 360 |
| 2 | Manager/Administrator | ECSR | 1,178 |
| 2 | Salesman | ECSR | 309 |
| 4 | Salesman | (ECRS) | 64 |
| 4 | Marketing Man | ECSI | 45 |
| 2 | Radio/TV Announcer | ERAS | 157 |
| 4 | Public Relations & Advertising | EACS | 40 |
| 4 | Lawyer | EASI | 288 |
| 2 | Lawyer | (ESAI) | 244 |
| 4 | Government Officer | ESCA | 19 |
| 2 | Secretary | ESCA | 15 |
| 2 | Food & Hotel Technologist | ESRC | 137 |
| 4 | Educational Administrator | ESAI | 8 |
| 4 | Political Scientist | ESAI | 76 |
| 2 | Political Scientist | (SEIA) | 54 |
| E | Security Salesman | ESAI | 37 |

occupations aspired to by 2- and 4-year college students and (b) unstable definitions, because different samples of occupational aspirants and employed adults for the same occupation produce similar but not always identical VPI profiles. Consequently, the precise place of an occupation in the classification is sometimes unclear. (c) The value of the hexagonal arrangement is only partially explored so that it should be termed promising rather than substantiated. Finally, (d) employed adult samples may provide

**CONVENTIONAL CLASS (MEN)**

| *Sample* | *Occupation* | *Code* | *N* |
|---|---|---|---|
| 4 | Clerk | CRES | 6 |
| 4 | Business (Commercial) Teacher | CSER | 23 |
| 2 | Data Processing Worker | CERI | 502 |
| 4 | Finance Expert | CEIS | 91 |
| 2 | Accountant | CESR | 605 |
| 4 | Accountant | (CERS) | 279 |

different VPI profiles, although a few adult samples in the present classification imply that this occurrence is a remote possibility.

## Some Practical Uses

The potential uses of the classification are most promising for vocational guidance, personnel work, and research. In vocational guidance, the classification can be used to organize vocational information files and readings. Because the classes and subclasses arrange materials according to their "relatedness"—how psychologically distant one occupation is from another, or how far one occupational group is from another—students can use the classification for occupational exploration with little help. For example, counselors can use a student's current occupational choice, history of choices, or interest inventory scores to direct a student to appropriate occupational materials and to encourage him or her to look also at closely related materials.

The classification should also help interpret interest inventories, student occupational choices, and other student data in terms of a single theory. To illustrate, a boy's choice of mechanical engineering would be coded RIEC. And, if his Kuder code were Mechanical-Scientific-Persuasive-Computational, his profile would be equivalent to the classification code of RIEC. A student's Kuder profile can be translated into the Holland categories. (See Holland, 1966b, p. 37.) The counselor could also assess the student for his resemblance to a person with a personality pattern of RIEC.

## INTELLECTUAL CLASS (WOMEN)

| *Sample* | *Occupation* | *Code* | *N* |
|---|---|---|---|
| 4 | Architect | IASE | 8 |
| 4 | Agronomist | IASR | 15 |
| 2 | Veterinarian | IASR | 28 |
| 4 | Veterinarian | (ISAR) | 16 |
| 2 | Farmer | IACSR | 8 |
| 4 | Physicist | IARS | 7 |
| 4 | Biologist | ISAE | 40 |
| 2 | Chemical Eng. Technician | ISAE | 10 |
| 2 | Medical Technologist | ISAE | 127 |
| 4 | Medical Technologist | (SIAE) | 111 |
| 4 | Natural Science Teacher | ISAE | 45 |
| 2 | Physical Scientist | ISAE | 6 |
| 4 | Physician | ISAE | 79 |
| 2 | Physician | ISAE | 38 |
| 4 | Zoologist | ISAE | 13 |
| 4 | Biochemist | ISAR | 12 |
| 2 | Biological Scientist | ISAR | 42 |
| 4 | Biological Scientist | ISAR | 21 |
| 4 | Chemist | ISAR | 25 |
| 4 | Mathematician/Statistician | ISCA | 54 |
| 2 | Mathematician | (SCIA) | 36 |
| a | Pharmacist | ISEA | 46 |
| 2 | Pharmacist | (ISCE) | 7 |
| 4 | Pharmacist | (SIAE) | 15 |

[a]Students and faculty from three schools of pharmacy.

## ARTISTIC CLASS (WOMEN)

| Sample | Occupation | Code | N |
|---|---|---|---|
| 4 | Actress/Drama Coach | ASEI | 18 |
| 4 | Foreign Language Interpreter | ASEI | 42 |
| 4 | Foreign Service Worker | ASEI | 36 |
| 2 | Industrial Arts Teacher | ASEI | 5 |
| 4 | Industrial Psychologist | ASEI | 8 |
| 4 | Journalist | ASEI | 57 |
| 2 | Journalist | (ASIE) | 54 |
| 4 | Music Teacher | ASEI | 74 |
| 2 | Musician | ASEI | 50 |
| 4 | Musician | (ASIE) | 43 |
| 2 | Printer | ASEIC | 5 |
| 2 | Radio/TV Announcer | ASEI | 15 |
| 2 | Speech/Drama Teacher | ASEI | 38 |
| 2 | Draftsman | ASRE | 8 |
| 4 | Art Teacher | ASIE | 93 |
| 2 | Artist | ASIE | 217 |
| 4 | Artist | ASIE | 92 |
| 4 | Literature Teacher | ASIE | 22 |
| 4 | Writer | ASIE | 52 |
| 4 | Civil Engineering | ASIC | 6 |
| 2 | Architectural Draftsman | ASIR | 14 |
| 2 | Photographer | AIES | 17 |

The counselor might use the classification to show the student other RIEC occupations such as civil engineering or industrial engineering.

If he is unsure about his initial choice, the student can be directed to occupations in such related subgroups as aviation (RIES), farming (RIES), or drafting (RIEA). "Undecided" students or students unable to make choices can first explore the entire classification and then use occupational files organized by the same classification to obtain specific information.

## SOCIAL CLASS (WOMEN)

| Sample | Occupation | Code | N |
|---|---|---|---|
| 4 | Psychologist | SEIA | 6 |
| 4 | Buyer | SEAC | 55 |
| 4 | Educational Psychologist | SEAC | 15 |
| 2 | Food & Hotel Technician | SEAC | 53 |
| 2 | Saleswoman | SEAC | 95 |
| 4 | Saleswoman | SEAC | 25 |
| 4 | Business Teacher | SCEA | 89 |
| 4 | Clerk | SCEA | 94 |
| 2 | Industrial Eng. Technician | SCEA | 6 |
| 2 | Manager | SCEA | 77 |
| 4 | Manager | (SEAC) | 22 |
| 2 | Secretary | SCAE | 1,024 |
| 4 | Secretary | SCAE | 267 |
| 2 | Dental Technologist | SIAE | 6 |
| 2 | Nurse (Professional) | SIAE | 952 |
| 4 | Nurse (Professional) | (SAIE) | 301 |
| 2 | Nurse (L.P.N.) | SIAE | 75 |
| 4 | Physical Therapist | SIAE | 32 |
| 2 | X-Ray Technician | SIAE | 62 |
| 4 | Mathematics Teacher | SIAC | 114 |
| 2 | Optometrist | SIAC | 5 |
| 2 | Housewife | SAEC | 166 |
| 4 | Housewife | (SAEI) | 122 |
| 2 | Lawyer | SAEC | 48 |
| 4 | Lawyer | (SAEI) | 32 |
| 4 | Public Relations & Advertising | SAEC | 13 |
| 2 | Clothing Technologist | SAEI | 43 |
| E | Counselor | SAEI | 28 |
| 4 | Counselor | SAEI | 76 |
| 4 | Elementary Teacher | SAEI | 1,497 |
| 4 | English Teacher | SAEI | 306 |
| 2 | English Teacher | SAEI | 78 |
| 4 | Foreign Language Teacher | SAEI | 117 |

[Continued]

**Social Class (Women)** [*Continued*]

| *Sample* | *Occupation* | *Code* | *N* |
|---|---|---|---|
| 2 | Foreign Language Teacher | SAEI | 50 |
| 4 | Historian | SAEI | 24 |
| 2 | Historian | (SAIE) | 50 |
| 4 | History Teacher | SAEI | 154 |
| 4 | Home Economics Teacher | SAEI | 153 |
| 4 | Home Economist | SAEI | 184 |
| 2 | Home Economist | (SEAI) | 72 |
| 4 | Physical Ed. Teacher | SAEI | 239 |
| 2 | Physical Ed. Teacher | SAEI | 163 |
| 2 | Policewoman | SAEI | 12 |
| 4 | Social Worker | SAEI | 140 |
| 4 | Speech Teacher | SAEI | 22 |
| 4 | Special Ed. Teacher | SAEI | 145 |
| 2 | Cosmetologist | SACE | 30 |
| 2 | Medical Secretary | SACI | 201 |
| 4 | Aeronautical Engineer | SAIE | 9 |
| 4 | Astronomer | SAIE | 6 |
| 4 | Church Worker | SAIE | 34 |
| 2 | Church Worker | (SAEI) | 11 |
| 4 | Clinical Psychologist | SAIE | 48 |
| 4 | Dentist | SAIE | 32 |
| 2 | Dental Hygienist | SAIE | 209 |
| 4 | Experimental Psychologist | SAIE | 12 |
| 2 | Librarian | SAIE | 33 |
| 4 | Librarian | (SAEI) | 32 |
| 4 | Political Scientist | SAIE | 32 |
| 2 | Political Scientist | (SAEI) | 16 |
| 2 | Psychologist | SAIE | 98 |
| 2 | Social Service Worker | SAIE | 190 |
| 2 | Social Scientist | SAIE | 30 |
| 2 | Sociologist | SAIE | 55 |
| 4 | Sociologist | (SAEI) | 34 |
| 2 | Teacher | SAIE | 1,477 |
| 2 | Therapist | SAIE | 84 |
| 2 | Aviation Worker | SAIC | 10 |
| 2 | Dental Assistant | SAIC | 110 |

### ENTERPRISING CLASS (WOMEN)

| *Sample* | *Occupation* | *Code* | *N* |
|---|---|---|---|
| 4 | Marketing Woman | ECSA | 5 |
| 2 | Real Estate Agent | ESAC | 13 |

### CONVENTIONAL CLASS (WOMEN)

| *Sample* | *Occupation* | *Code* | *N* |
|---|---|---|---|
| 2 | Accountant | CSEA | 174 |
| 4 | Accountant | CSEA | 42 |
| 2 | Data Processing Worker | CSEA | 251 |
| 4 | Finance Expert | CESI | 7 |

A person's conflicting occupational choices can also be classified and examined for their special character and psychological distance from one another. Using the theory, a counselor can explicitly and theoretically define a student's occupational conflict—a process which might aid both the student and the counselor. For example, a boy trying to decide between engineering (RIEC) and farming (RIES) should experience little conflict. A discussion of "C" and "S" or "Conventional" and "Social" types might simplify his decision. In contrast, a boy who is trying to decide between chemistry (IRAS) and law (ESAI) has a much more difficult task because his interest in such diverse occupations mirrors diverse personal opinions about himself.

The classification may aid industrial personnel work; subgroups of similar occupations could be used in recruitment to center attention on potentially profitable recruitment areas. For instance, if recruiters need trainees for a specific occupation and cannot find enough prospects, the classification specifies related occupations which might yield interested candidates. Because most organizations find that some types of people are more successful than others, the classification provides a systematic nomenclature for interpreting this common occurrence and using the information accordingly. For example, employees with long and short tenure can be compared in terms of their VPI profiles.

Finally, and equally important, the classification creates some exciting research possibilities. The four-letter codes provide theoretical descriptions for the typical person in each occupation. These theoretical descriptions should be helpful for interpreting occupational data and occupational differences. For example, a male social worker (SIEA) should display the characteristics of Social-Intellectual-Enterprising-Artistic types and in that order. (See Holland, 1966b, for information about the types.) The classification allows a researcher studying vocational behavior to investigate a person's training, occupational aspirations, and work history within the framework of a single classification and theory. Literally, a person's life can be considered a series of coded choices which can be studied for their patterns, stability, and mathematical relationships. In other research, the classification can be used to organize and interpret occupational census information so that some educational and sociological studies which must now rely on crude, ambiguous classifications will have a more constructive alternative. Depending upon the variety of occupations studied and the size of the sample, a researcher can use the main six categories, the two-, the three-, or the four-letter subcategories. The earlier study (Holland, 1968b) demonstrated that categories become more homogeneous or clearly defined as one moves from single- to two- and three-letter codes. In short, a researcher can modify the classification to meet his or her particular needs.

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Chapter 2

# AN ANALYSIS OF SPATIAL CONFIGURATION

*Nancy S. Cole and James W. L. Cole*

An analysis designed for the study of relationships among variables is presented. Using principal component methods, the analysis treats variables as vectors and fits a smaller-dimensioned space to the vectors where possible. The result of the analysis is often a two-dimensional plot of the variables. A second part of the analysis relates variables and individuals in the same reduced space. This procedure preserves information about the shape of an individual's profile of scores and reduces that information to a single location among the variables. Both parts of the analysis are applied to measures of colleges and the advantages and disadvantages of the analysis are discussed.

Measurement instruments in the social sciences are often multivariate. Rarely, however, are the variables independent. Typically more variables are used than the dimensionality of the data suggests. Factor analysis (or principal components analysis) is commonly used to identify dimensions of multivariate data. The purpose of factor analysis is to reduce the number of variables by replacing them with fewer new variables or dimensions.

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However, it is not uncommon that the original variables are measures of meaningful characteristics while the dimensions or factors are not similarly meaningful nor conducive to direct measurement. If either for practical or theoretical reasons the original variables are important in themselves, then the concern may be with the relationships among the variables as they are, rather than with replacing them with fewer variables. When we want to know about relationships among the original variables, another method of analysis is needed.

Information about the relationships among variables is contained in the correlation matrix. Because it is difficult, if not impossible, to interpret simultaneously the correlations in a matrix, a method of reducing the information is necessary in order to simplify variable comparisons. The analysis of spatial configuration presented in this paper uses the dimension reduction techniques of principal components analysis in order to reduce the dimensionality of the space in which the variables are imbedded while retaining the variables. The representation of the relationships among the variables in a smaller dimensioned space allows those relationships to be more easily understood and often even visually represented.

The first section of the paper describes the use of common statistical techniques in a new way to represent in a simple form the configuration (or relation) of the variables. In the second section a method for relating individuals and variables in the same configuration is suggested. This method provides a representation of important aspects of some kinds of profile data with several advantages over the usual profile form. Finally, in the third section the analysis is applied to a sample problem in which its advantages and disadvantages are clear.

## The Analysis of Variable Configurations

In spite of its different purpose and result, factor analysis suggests a method which is helpful in the consideration of variable relationships. In factor analysis, variables are commonly plotted using the factors as axes. However, since only two dimensions can be drawn easily, factor analysts have usually plotted the variables on various pairs of factor axes. This procedure, while useful, produces several two-dimensional plots which must be simultaneously assimilated in order to effectively conceptualize variable relationships. However, as a first step in a method designed to simplify such a conceptualization, the variables may be considered in the space of all the component or factor axes, not just on pairs. Thus, the initial stage of the analysis of spatial configuration is to locate the variables in the space of all the principal components.

*First Stage Principal Components Analysis*

Consider an N x p matrix of p observations on each of N individuals. When this matrix is standardized with respect to the sample means and variances, the resulting N x p matrix will be called Z.[1] If Z is considered by columns, each N x 1 column vector representing one of the p variables can be plotted in N-space. In such a space, the correlation between variable i and variable j equals the cosine of the angle between the i-th and j-th column vectors of Z (Harman, 1960, p. 62). Thus the p N-dimensional vectors representing the p variables are related by the angles or correlations between them, and these correlations are the basic relationships which we seek to summarize for easier understanding.

Since p points can always be represented in p-space and $p < N$, this N-space can clearly be reduced. One way to reduce the N-space is to perform a principal components analysis on the p x p correlation matrix $R = Z'Z/N$. The result of this analysis is a p x p loading matrix, A. The columns of A are the principal components which are linear combinations of variables with the properties that the i-th component is the normalized linear combination which maximizes the variance orthogonal to the first i-1 components (Anderson, 1958). However, we are interested in the principal components not because of these variance maximizing properties but because they provide axes for a p-space in which the variables may be represented in the same configuration as in the N-space.

The rows of A represent the locations of the variables in the p-space of the principal components. It can be shown that the row vectors of A are all the same length just as were the column vectors of Z and that the angles between the rows of A are the same as the corresponding angles between the columns of Z in N-space. Thus, the variable vectors in p-space maintain precisely the same relationships to one another as the original column vectors of Z and preserve all the information about variable relationships contained in the correlation matrix. It is this property of principal components, the preservation of the configuration of the vectors in N-space, which is crucial at this stage of the analysis. Geometrically, the vectors representing variables can be conceived of as points falling at the surface of a unit hypersphere.

[1]Standardizing the variables with respect to their sample variances as well as means may sacrifice useful information contained in the relative magnitudes of the variances. However, in the social sciences such information is often of little value. Moreover, the standardization of the variables has a beneficial effect on their behavior under this analysis which will become clear.

*Second Stage Principal Components Analysis*

In the first stage of the analysis the variables were located in the p-space of the first stage components and their original spatial configuration was preserved. However, visualizing or understanding relationships of variables in a many-dimensioned space is, of course, impossible. The points on the surface of the hypersphere representing variables might be approximately embedded in a smaller dimensioned subspace of the p-space in which a simpler representation of the variable relationships could be achieved. This possibility can be examined by a principal components analysis performed on the variable points.

The second stage principal components analysis can be interpreted as a kind of fitting procedure. This interpretation of the analysis involves the definition of a subspace of an original space with certain optimum properties. For example, consider m vectors in p-space. The first k ($k < p$) principal components define a k-dimensional subspace of the p-space for which the sum of squared deviations of the m vectors from the k-space is minimized. Thus the k principal components define a "best-fitting" k-space for the m p-variate vectors. Therefore, principal components analysis may be applied to the p variable points in p-space and the first component will represent the line which best fits the variable points, the first two components give the best-fitting plane, etc. At this stage, principal components analysis is used because of these "fitting" properties and other dimension reduction methods would not be appropriate.

At the second stage of the analysis only the variation of the variable points in p-space is considered. Thus, the variables play the same role at this stage as individuals played in the first stage components analysis. In the usual analysis there are individuals with scores on each of several variables. In this case there are p variables with scores on each of p dimensions. Thus the covariance matrix, S, of the p dimensions over the p variables corresponds to the usual covariance matrix of variables over individuals.

$$S = (1/p)A'A - \overline{\underline{a}}\,\overline{\underline{a}}' , \tag{1}$$

where for $\underline{a}_i'$ the i-th row of A,

$$\overline{\underline{a}} = (1/p) \sum_{i=1}^{p} \underline{a}_i . \tag{2}$$

A principal components analysis of S yields characteristic roots and a loading matrix, say B. If the first k principal components account for a large percentage of the trace of S, then the space of the variables can be reduced to a k-space. In other words, if the last $p - k$ roots are small, this indicates that the points deviate little from the k-dimensional space spanned by the first k component vectors.

*Projection of the Variables onto a Smaller Subspace*

The p variable points in p-space can be projected onto the k-dimensional subspace identified by the second stage components analysis. This projection is made in the same way that individual points are projected onto the factor space by the computation of factor scores in the usual analysis.

If $A_*$ is the matrix A standardized for the mean $\underline{\bar{a}}$ defined in (2) such that

$$A_* = A - \underline{1}\,\underline{\bar{a}'} \,, \tag{3}$$

then $A_*$ corresponds to the Z matrix for individuals in a components analysis of individual variation. Thus, by the usual factor analytic model (Harman, 1960, p. 360), each element of a row of $A_*$ may be expressed as a linear combination of the k component scores. The loading matrix B gives the weights of the combination and the component scores, say $\underline{g}_i$(k x 1), are unknown for each of the i = 1,...,p variables. The model[2] can be stated simultaneously for all p variables as

$$\underset{pxp}{A'_*} = \underset{pxkxp}{B\,G} \,, \tag{4}$$

where we consider G as p column vectors, $\underline{g}_i$. The elements of $\underline{g}_i$ are scores on the k components (the k columns of B or the k dimensions of the best-fitting k-space). Since the k components are possibly of different lengths, it is convenient to transform the $\underline{g}_i$ to a unit basis so that the variables can be plotted graphically in the usual way. Such plots are especially helpful when $k < 3$ so that the spatial configuration of the variables may be easily visualized in graphic form.

The transformed component scores, H, are obtained by normalizing the columns of B.

$$\underset{pxp}{A'_*} = \underset{pxkxpxk}{B(B'B)^{-1/2}}\underset{kxpxk\ xp}{(B'B)^{1/2}G}$$

$$= B(B'B)^{-1/2}\,H, \tag{5}$$

where B'B is a diagonal matrix of characteristic roots and $(B'B)^{-1/2}$ is the corresponding diagonal matrix of inverse square roots of the characteristic roots.

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[2]The usual factor analytic model when applied to individuals in the first stage components analysis is Z' = A F where F is the q x N matrix of unknown component scores for N individuals and q is the number of factors under consideration.

$H = \left[ \underline{h}_1 \mid \underline{h}_2 \mid \ldots \mid \underline{h}_p \right]$ can be found by

$$H = (B'B)^{-1/2} B'A'_* \quad . \tag{6}$$

The overall fit of the variable points to the k-space is given by the percent of the trace accounted for by the k characteristic roots. In addition, we can explore what portion of the variation not accounted for by the k-space is attributable to deviation of which variable from the k-space.

In treating $A'_*$ as column vectors of individual observations, we see that the sum of squares for the i-th column of $A'_*$ (say $V_{pi}$) gives the variation of the i-th variable, and the sum of this variation over all p variables (say $V_p$) gives the total variation in $A'_*$. It is also true that the sum of squares for the i-th column of H (say $V_{ki}$) gives the variation of the i-th variable accounted for by the k-space, and the ratio $V_k/V_p$ corresponds to the percent of the trace already discussed.

Of special interest here, however, is the fact that $(V_{pi} - V_{ki})$ gives the variation of the i-th variable about the k-space and $(V_{pi} - V_{ki})/V_p$ gives the percentage of the trace due to that variation. With these values we can judge not only overall fit of the variables to the k-space, but also discover which variables give the poorer fit.

### Relating Variables and Individuals in the Same Space

An individual's vector of scores is often used as a profile in psychological and educational applications. A profile is frequently interpreted as demonstrating an individual's relative orientation to the variables in the profile. For example, if the variables are areas of vocational interest, then a profile with a single dominant peak is interpreted as representing a dominant orientation to one area of interest while a profile with several peaks is interpreted as representing a mixed interest orientation. If the variables are scores on personality measures, then again the shape of the profile may be interpreted as demonstrating the individual's relative orientation to different personality types.

In the first part of the analysis of spatial configuration, a configuration of the variables in the smallest possible subspace was achieved. Such a subspace might be interpreted as a space in which the different areas of the space represent different types of profiles or orientations to different variables. With this possible interpretation in mind, the potential value of locating individuals in the same space as the variables becomes clear. By such a procedure individual profiles could be summarized by the area in the space in which they were located and the variables which they were near. Such a possibility motivated the development of the following method of relating individuals and variables in the same space.

*Location of Individuals and Variables in the Space of the First Stage Components*

In the first stage principal components analysis, rows of the loading matrix A were used to locate the p variables on the p component axes. From the factor analytic model (cf. footnote 2) we know that an individual's score on variable i can be expressed as a linear combination of factor scores in which the i-th row of A provides the weightings of the combination. Thus, for the j-th individual,

$$\underset{p\times 1}{\underline{z}_j} = \underset{p\times p\times 1}{A\,\underline{f}_j}, \qquad j=1,\ldots,N, \tag{7}$$

where $\underline{z}_j'$ is the j-th row of Z and $\underline{f}_j$ is the vector of unknown factor or component scores for the j-th individual. When A is of full rank (the situation assumed here), $\underline{f}_j$ may be found by inverting A,

$$\underline{f}_j = A^{-1}\,\underline{z}_j \;. \tag{8}$$

The scores $\underline{f}_j$ then locate an individual observation vector in the p-space of the principal components, the same p-space in which the variables were located. It is reasonable then to consider if some common meaning can be given to a vector representing a variable (a row of A) and a vector representing an individual ($\underline{f}_j$) in this p-space so that both can be considered simultaneously in the same space.

Since $\underline{f}_j$ ($j = 1,\ldots,N$) and the rows of A, $\underline{a}_i'$ ($i = 1,\ldots,p$), have been located in the same p-space, a first concern is to find what vector $\underline{z}$ for an individual corresponds to a vector $\underline{f}$ which equals a variable vector $\underline{a}_i$. In other words, when the representation of an individual in the p-space of the components ($\underline{f}$) and that of a variable ($\underline{a}_i$) are identical, what $\underline{z}$ corresponds to the $\underline{f}$? Since $\underline{z}$ is related to $\underline{f}$ as given in (7), substitution of $\underline{a}_i$ for $\underline{f}$ in that equation gives the $\underline{z}$ corresponding to the location of the i-th variable, $\underline{z}^*_{(i)}$,

$$\underline{z}_i^* = A\underline{a}_i \;. \tag{9}$$

By the rules of matrix multiplication, $\underline{z}^*_{(i)}$ is equal to the i-th column of AA' which is known to equal the correlation matrix, R. Thus, for $\underline{r}_i$, the i-th column of R,

$$\underline{z}^*_{(i)} = \underline{r}_i \;. \tag{10}$$

This means that, if we can conceive of a vector of scores on all p variables as representing a single variable, then the column (or row) of R gives that representation resulting from this method of combining variables and individuals.

One possible way of conceiving of scores on several variables as representing a single variable is to consider the typical $\underline{z}$ of individuals whose scores are dominated by the single variable in question. Consider, for example, individuals who score 1.0 on the i-th variable (one standard deviation above the mean for that variable). Then the conditional expectation of the z scores for the other p-1 variables, given the score of 1.0 on the i-th variable, can be shown to be equal to the correlations of the other variables with the i-th variable (Anderson, 1958). Thus, considering the i-th row of the correlation matrix as a vector of z scores, such a vector is typical of individuals scoring 1.0 on the i-th variable, and in that sense typical of the variable itself.

However, other vectors would be typical of individuals who scored other than 1.0 on the i-th variable. In general, given a z score of $z_0$ on the i-th variable, the expectation of the other variables is $z_0$ times their correlations with the i-th variable. Thus, although $\underline{r}_i$ uniquely defines a direction which has a meaningful interpretation as representing a variable, the particular length of that vector taken as 1.0 is completely arbitrary.

Even though there is appeal to equating vectors which are multiples of each other on the basis of this conditional expectation argument, other types of equivalence classes might be even more useful in practical applications. Consider, for example, the use of profiles of scores in interest measurement. In that situation, the relative degree of interest of the individual in each of several interest areas is often the dominant concern. For such characterizations within a profile, it is the shape of the profile (rather than the level) which provides the important information. In a case such as this it would be desirable to equate $\underline{z}$ and $\underline{z} + \underline{c}$ (where $\underline{c}' = [c, c, \ldots, c]$). Then all individuals with profiles of the same shape would fall at the same location and similarly all profiles of a particular shape would represent a particular variable.

Although no equivalence set of $\underline{z}$'s is achieved in the space of the first stage principal components either on the basis of the conditional expectation argument or the profile shape argument, the first argument provides some meaning for the use of $\underline{r}_i$ as representative of the i-th variable and the second provides the basis for an equivalence of $\underline{z}$'s which will be established in the next section.

### *Locations of Variables and Individuals in the Subspace of the Second Stage Components*

Variables were projected onto the subspace of the second stage components in order to consider their configuration in a smaller, more easily understood subspace. After locating individuals along with variables in the space of the first stage components, individuals too may be projected onto this smaller subspace. Equation (6) gives the projection of a variable onto the subspace. In that equation $A_*'$ is made up of p column vectors of the form $\underline{a}_i - \bar{\underline{a}}$ and H is p column vectors, $\underline{h}_i$. Since $\underline{a}_i$ corresponds to factor scores $\underline{f}$ for individuals, in order to project individuals onto the smaller space we need only substitute $\underline{f}$ for $\underline{a}_i$ in (6). This gives $\underline{h}_j^*$ where $\underline{h}^*$ is the point in the smaller space representing an individual,

$$\underline{h}_j^* = (B'B)^{-1/2}B'(\underline{f}_j - \bar{\underline{a}}) \quad , \quad j=1,\ldots,N . \tag{11}$$

It is convenient to express $\underline{h}^*$ directly in terms of the vector $\underline{z}$. From (8) $\underline{f}$ can be expressed in terms of $\underline{z}$. In addition, since $\bar{\underline{a}}$ is just the average of the $\underline{a}_i$ over the p variables, from (9) and (10) we see that

$$\bar{\underline{a}} = A^{-1}\ \bar{\underline{r}} \ , \tag{12}$$

where

$$\bar{\underline{r}} = (1/p) \sum_{i=1}^{p} \underline{r}_i \ . \tag{13}$$

Therefore, we may express $\underline{h}_j^*$ directly in terms of $\underline{z}_j$ by

$$\begin{aligned} \underline{h}_j^* &= (B'B)^{-1/2}B'A^{-1}(\underline{z}_j - \bar{\underline{r}}) \quad , \quad j=1,\ldots,N \\ &= P(\underline{z}_j - \bar{\underline{r}}). \end{aligned} \tag{14}$$

One characteristic of P has special significance for practical applications. It can be shown that when R is nonsingular, the rows of P sum to zero. This characteristic has implications for the equivalence classes of $\underline{z}$'s which map into the same location in the smaller subspace. Consider two observations $\underline{z}_1$ and $\underline{z}_2$ where $\underline{z}_2 = \underline{z}_1 + \underline{c}$. Then

$$\underline{h}_1^* = P(\underline{z}_1 - \bar{\underline{r}})$$

and

$$\begin{aligned} \underline{h}_2^* &= P(\underline{z}_1 + \underline{c} - \bar{\underline{r}}) \\ &= P(\underline{z}_1 - \bar{\underline{r}}) + P\underline{c} \\ &= P(\underline{z}_1 - \bar{\underline{r}}) \\ &= \underline{h}_1^* \ . \end{aligned} \tag{15}$$

Thus, if two vectors in the original space of the z scores differ by a constant (if the shapes of the profiles are identical but the profiles differ in level), then those two vectors map into exactly the same point in the smaller space, the space of the second stage principal components. Thus, the projection onto the smaller space defines an equivalence of vectors which map into the same point. One basis of this equivalence is the shape of the $\underline{z}$ profile; same shapes map into the same point.

In addition, $\underline{z}$ vectors of different shapes may also map into the same point in the smaller space. The basis for this aspect of equivalence in the smaller space can be understood by considering the projection matrix P. From equation (14) it is clear that the location of an individual in the smaller space ($\underline{h}^*$) is a weighted sum of the columns of P in which the weights are the elements of the difference vector ($\underline{z}$-$\underline{\bar{r}}$). Thus, the columns of P may be thought of as forces for each variable whose weighted resolution locates an individual in the smaller space. Any $\underline{z}$ vectors which give the same weighted resolution of the forces in P will be equivalent in the smaller space (will map into the same point). In terms of a balance or resolution of forces, this means that all vectors which map into the same point in the smaller space represent the same balance of the forces of P. As already noted, $\underline{z}$ vectors of the same shape represent the same balance or resolution of these forces.

### An Application of the Analysis to Measures on Colleges

In his book, *Who Goes Where to College?*, Astin (1965) presented scores for 1,015 colleges on five variables based on student characteristics which were given the following names and interpretations (Astin, 1965, pp. 54-55).

1. *Intellectualism* (INT). An entering student body with a high score would be expected to be high in academic aptitude (especially mathematical aptitude) and to have a high percentage of its students pursuing careers in science and planning to go on for the PhD degrees.

2. *Estheticism* (EST). An entering student body with a high score would tend to have a high percentage both of students who achieved in literature and art during high school and of students who aspire to careers in these fields.

3. *Status* (STA). An entering student body with a high score would be expected to have a high percentage of students who come from high socioeconomic backgrounds and who themselves aspire to careers in Enterprising fields (lawyers, business executives, politicians).

4. *Pragmatism* (PRA). An entering student body with a high score would tend to have a high percentage of students planning careers in Realistic fields (engineering, agriculture, physical education) and a low

percentage of students planning careers in Social fields (teaching, sociology, psychology, nursing).

5. *Masculinity* (MAS). An entering student body with a high score would tend to have a high percentage of men, a high percentage of students seeking professional degrees (LLB, MD, DDS), and a low percentage of students planning careers in Social fields.

These five variables are of special interest in themselves primarily because they are similar to commonly used measures of student attributes. Four of the five variables are related to Holland's (1966) six categories of vocational interest (Realistic, Intellectual, Artistic, Social, Enterprising, and Conventional). These categories of vocational interest have been shown to have a circular configuration (Holland, Whitney, Cole, and Richards, 1969; Cole, Whitney, and Holland, 1971). Thus, in this analysis, the interest is in whether the variables on colleges have a similar relationship to each other as corresponding variables for individuals do and, in addition, whether colleges can be characterized meaningfully by the interests of their students in a manner similar to that by which individual interests are characterized.

*First Stage Principal Components Analysis*

The correlation matrix of the five variables for the 1,013 colleges with complete data is presented in Table 1. The variables were given by Astin in a

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**TABLE 1**

**Intercorrelations of Astin Variables**

| | *INT* | *EST* | *STA* | *PRA* | *MAS* |
|---|---|---|---|---|---|
| INT | 1.00 | | | | |
| EST | .34 | 1.00 | | | |
| STA | .54 | .18 | 1.00 | | |
| PRA | .43 | −.34 | .10 | 1.00 | |
| MAS | .38 | −.46 | .43 | .61 | 1.00 |

**Note.**—The correlation matrix given here was computed from Astin's data but does not agree exactly with his (Astin, 1965, p. 50). The reason for the discrepancy is not known. However when the analysis was performed on Astin's matrix, essentially the same results were found.

standardized form with mean of 50 and standard deviation of 10, but all references to them here will be in an alternate standardized form with mean zero and standard deviation of one.

A principal components analysis was performed on R and the results are given in Table 2. The rows of A, the 5 x 5 loading matrix in Table 2, locate the variables in the five-space of the first stage components.

**TABLE 2**

**Principal Components Analysis of the Correlation Matrix of Astin Variables**

| Components: | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| Roots: | 2.281 | 1.591 | 0.711 | 0.220 | 0.197 |
| Percent Trace: | 45.6 | 31.8 | 14.2 | 4.4 | 3.9 |
| Loadings: | | | | | |
| INT | .7110 | .5640 | .2862 | −.2411 | −.1908 |
| EST | −.2390 | .9002 | .2399 | .0649 | .2662 |
| STA | .6174 | .5185 | −.5429 | .2183 | −.0870 |
| PRA | .7638 | −.3256 | .4837 | .2766 | .0062 |
| MAS | .8680 | −.2965 | −.2079 | −.1834 | .2861 |
| Mean | .5442 | .2721 | .0518 | .0271 | .0561 |

*Second Stage Principal Components Analysis*

The covariance matrix S of the five components over the five variables is

$$S = \begin{bmatrix} .1599 & & & & \\ -.1481 & .2442 & & & \\ -.0282 & -.0141 & .1396 & & \\ -.0147 & -.0074 & -.0014 & .0433 & \\ -.0305 & -.0153 & -.0029 & -.0028 & .0362 \end{bmatrix} \quad (16)$$

Table 3 gives the results of a principal components analysis on S. The first two dimensions in the second stage analysis account for 81.2% of the trace. Thus, the deviations of the variable points from their centroid in the five-space is almost contained in a space of two dimensions (i.e., a plane). Because of the value of providing a visual representation, we take k = 2.

TABLE 3

**Second Stage Principal Components Analysis**

| Components: | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| Roots: | 0.356 | 0.149 | 0.073 | 0.044 |
| Percent Trace: | 57.2 | 24.0 | 11.7 | 7.1 |
| Loadings: | | | | |
| 1 | −.3621 | −.0909 | .1433 | .0047 |
| 2 | .4742 | −.0826 | .1120 | .0035 |
| 3 | .0161 | .3655 | .0756 | .0019 |
| 4 | .0057 | .0128 | −.0864 | .1888 |
| 5 | .0117 | .0259 | −.1640 | −.0921 |

*Projection of the Variables onto a Smaller Subspace*

The matrix B is the 5 x 2 portion of the loading matrix outlined in Table 3. The locations of the five variables on the plane, computed as in equation (5), are

$$H = \begin{array}{c} \begin{array}{ccccc} \text{INT} & \text{EST} & \text{STA} & \text{PRA} & \text{MAS} \end{array} \\ \begin{bmatrix} 0.1296 & 0.9835 & 0.1344 & -0.5950 & -0.6526 \\ 0.0946 & 0.2432 & -0.6354 & 0.4893 & -0.1918 \end{bmatrix} \end{array} . \quad (17)$$

Using H, the variables were plotted on the plane to give a pictorial representation of the relationships among them. This representation is given in Figure 1. The distances between the variable points as specified in the five-space of the first stage components provide a geometrical interpretation of the idea of distance implied in the correlation matrix as a measure of relatedness. The reduction to the plane retains those aspects of the distances accounted for by the variability in the two dimensions. Thus, to the degree that the variable points fit the plane, as measured by the portion of the trace corresponding to the two dimensions, highly correlated variables will be represented by proximal points in Figure 1 and conversely.

The four variables which are related to Holland's interest categories (PRA, INT, EST, STA) are arranged in Figure 1 generally in the ordering found by Holland et al. (1969). The INT variable is nearer the center of the

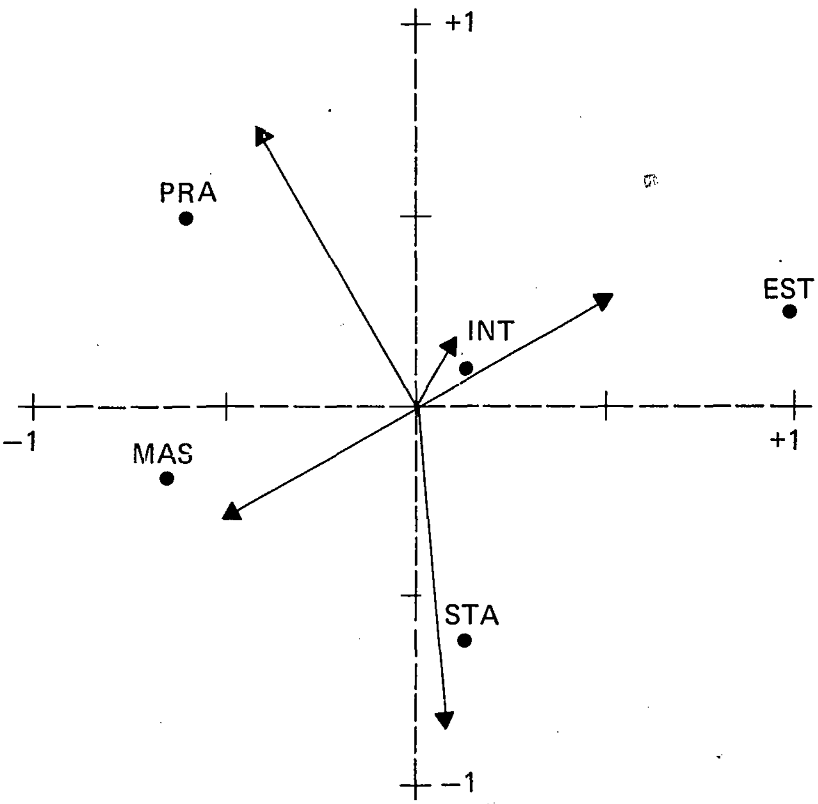



**Fig. 1.** Location of variables and their forces on a plane.

configuration than expected, but this may be due to the fact that it includes not only scientific interests (Holland's Intellectual) but also academic aptitude, an element not included in Holland's scheme. The STA variable also includes an extraneous element, socioeconomic status, in addition to Holland's Enterprising orientation. However, that variable is in the expected relationship to the other variables. Thus, the analysis of spatial configuration generally confirms a hypothesized configuration of the Astin variables.

In addition, from Table 4 we can see which variables deviate from the plane. The deviation of the INT variable was expected because it fell at the center of the planar configuration. However, it should be noted that MAS deviated from the plane more than the other three variables.

**TABLE 4**

**Deviation of Variables from the Plane**

| | *INT* | *EST* | *STA* | *PRA* | *MAS* | *Total Dev.* |
|---|---|---|---|---|---|---|
| $V_{5i} - V_{3i}$ | .2751 | .0623 | .0551 | .0634 | .1301 | .5860 |
| % Trace Due to Deviation | 8.8% | 2.0% | 1.8% | 2.0% | 4.2% | 18.8% |

*Relating Variables and Colleges in the Same Space*

The projection matrix P for locating an individual observation vector (a college) on the plane is computed as in equation (14).

$$P = \begin{bmatrix} 0.0727 & 0.5520 & 0.0755 & -0.3339 & -0.3662 \\ 0.1265 & 0.3252 & -0.8498 & 0.6545 & -0.2565 \end{bmatrix} . \quad (18)$$

Premultiplication of a college's adjusted vector of scores $(\underline{z} - \underline{\overline{r}})$ by P gives the college's location on the plane. The columns of P, which may be thought of as forces on each variable whose weighted resolution locates a college in the plane, are indicated by arrows in Figure 1.

The location of Intellectualism (INT) near the center of the plane and with a very small force in the projection matrix means that the INT score of a college has a relatively small effect in differentiating colleges in this plane. Thus, when regions of the plane near variable points are considered as relative orientations which colleges may have, the other four variables are more dominant as orientation differentiators than the INT variable.

This relatively small importance of the INT variable illustrates an interesting aspect of this analysis. Variables which are nearly equally correlated with all the other variables will contribute little to locating colleges in regions which differentiate colleges and thus the analysis will not reflect differences between colleges on that variable. Thus on the one hand the analysis reveals the fact that colleges with each of the other four orientations may be either high or low in INT and that no orientation is systematically higher or lower than others. That is to say, INT, with the strong influence of academic aptitude and educational plans, cuts across other orientation variables. On the other hand, the magnitude of the INT variable, which may be of interest in itself, is largely ignored in this analysis.

We first compare the information provided by a college's planar location with that provided by the usual profile interpretation. Astin (1965) discussed within institution and between institution profile comparisons as well as comparisons with institutions in general by usual profile interpretive methods. In all three cases, profile comparisons required variable by variable comparisons without any summary of characteristics of the profiles as a whole. The great advantage of the analysis of spatial configuration is that it summarizes the variable by variable comparisons into a single point and at the same time relates that point to the original variables. Each college's location on the plane is the result of a within college comparison of the relative z-scores on the variables. Distances between college locations on the plane provide between college comparisons which may be interpreted in terms of relative distances from variable locations on the plane. Finally, the distance of an institution's point from the planar point corresponding to $\underline{z}' = (0,...,0)$, the mean of all institutions, provides the comparison with institutions in general.

In all cases, the comparisons using the planar locations are based on profile shape, not level. Summarizing a profile shape using the analysis of spatial configuration is a great advantage only when the profile shape is important. Astin, however, also made comparisons based on profile level. That information is lost in the planar configuration. In the present situation our concern is with the relative orientation of colleges to different aspects of the educational enterprise. For this purpose the analysis of spatial configuration is appropriate and gives unique information.

Now we consider the implications of the college locations on the plane as given in Figure 2. The large state universities and technical institutes, located in the upper left quadrant, demonstrate the relative orientation of these institutions to Realistic (engineering, etc.) rather than Social fields. As public institutions they lack a strong Status domination, have some Masculinity pull, and as a result are located generally to the upper left.

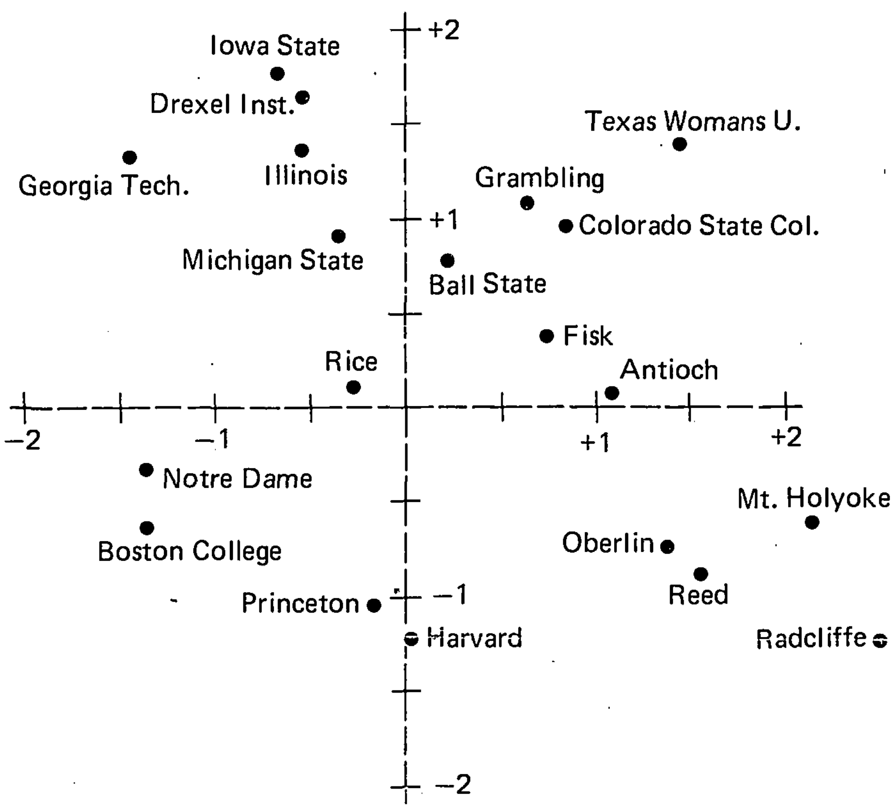
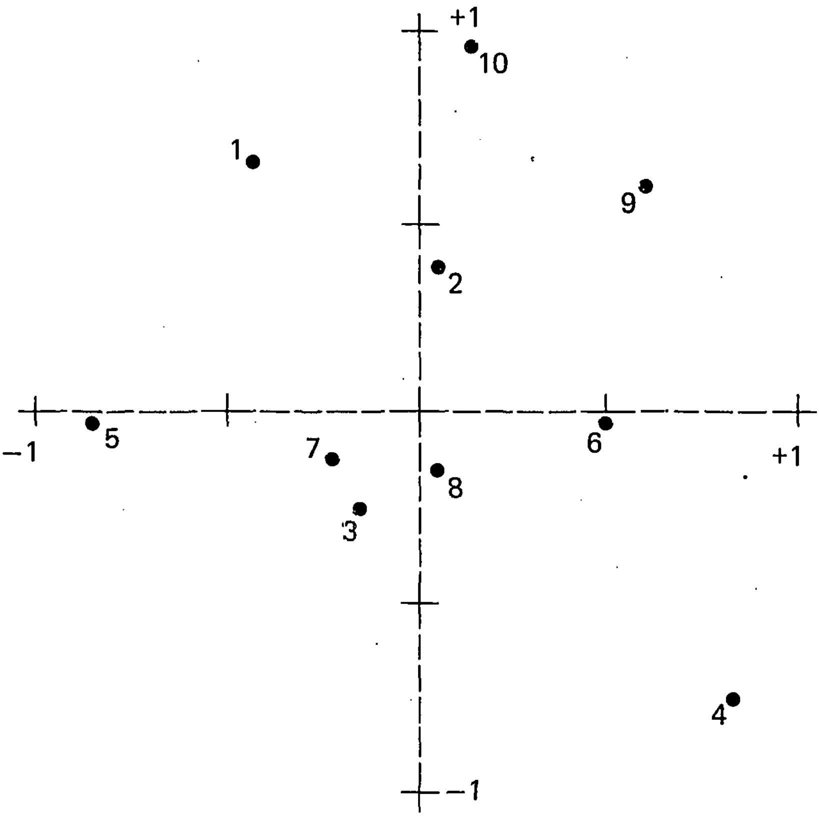



Fig. 2. Location of colleges on the plane.




1. Public universities (109)
2. Public liberal arts colleges (137)
3. Private nonsectarian univ. (46)
4. Private nonsect. lib. arts col. (89)
5. Catholic universities (26)
6. Catholic lib. arts col. (153)
7. Protestant universities (28)
8. Protestant lib. arts col. (231)
9. Teacher colleges (42)
10. Predominantly Negro col. (59)

**Fig. 3.** Location of groups of colleges on a plane.

Teacher colleges and some former teacher colleges are located to the upper right, reflecting the relative strength of their Social and Artistic orientations. Note that two predominantly Negro colleges fall in that quadrant also, suggesting a similarity in orientation with the teacher colleges. Several small, elite private women's colleges and artistically-oriented liberal arts colleges are located in the lower right quadrant. These colleges show STA and EST orientations. Elite private universities have the strong STA orientation also but with more MAS pull and less Social and EST pull and thus are located to the lower middle and lower left.

These observations about types of institutions can be made more systematically by computing means for groups of colleges of the same type. Ten types of colleges are given in Figure 3 along with the number of colleges included in each group. The locations of college group means in Figure 3 support the observations about types of colleges. Thus, consistent and meaningful distinctions can be made about colleges on the basis of this analysis of spatial configuration. Furthermore, it seems that one can consider the orientations of American colleges and universities in terms of characteristics of their students and demonstrate great diversity of institutions in this framework with little reference to or implication of corresponding differences in academic ability of the students.

*Summary and Conclusions*

The analysis of spatial configuration provided a useful method for examining the relationships among the Astin variables. The resulting configuration of the college measures generally corresponded to the configuration of similar measures of individual interests. In addition, relating colleges and variables in the same reduced space provided a meaningful summary description of the colleges in terms of their relative orientations to the variables.

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Chapter 3

# A SPATIAL CONFIGURATION OF OCCUPATIONS

*Nancy S. Cole, Douglas R. Whitney, and John L. Holland*

A mathematical analysis of the relationships among the six scales of Holland's Vocational Preference Inventory (VPI) yielded a representation of the six VPI scales in a "best-fitting" plane. The projection of VPI means of occupational groups onto that plane gave a spatial map of occupations in which the degree of relatedness was represented by the distance in the plane. The planar configuration was used to measure several concepts of vocational psychology and to test two initial hypotheses.

In a recent paper, Holland et al. (1969) presented a revised empirical classification of occupations using the six scales of Holland's Vocational Preference Inventory (VPI) and based on his theory of the psychology of vocational choice. An important result reported in that paper was the hexagonal configuration model for the six VPI scales. The hexagonal arrangement was supported by a statistical analysis which located the six scales in a "best-fitting" plane. This paper extends that formulation to the location of individuals and occupational groups on the plane.

The present analysis was performed to show the relationship among occupational groups. The need frequently arises in vocational counseling

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for a method of suggesting potential careers related to a client's expressed interests. Clients who are undecided or at an exploratory stage in their vocational development may be assisted by referring them to groups of related occupations. In addition, in research the concept of relatedness or degree of similarity of occupations often arises. This study offers a method for defining "related" occupations which has implications for counseling and research.

The statistical approach used in the present study results in a visual and spatial organization of occupations. The resulting spatial representation is presented and some of the implications of the configuration are discussed.

## Method

*Data*

The data for this study were VPI scores and expressed vocational choice of male college freshmen. The VPI is a list of occupational titles on which students check those that interest them. The occupational titles are grouped into scales of Realistic, Intellectual, Social, Conventional, Enterprising, and Artistic vocational interests which correspond to Holland's (1966b) personality types. A score on each of the six scales was obtained for each student. Expressed vocational choice was obtained by asking the students to select from a list of over 70 occupations "the occupation you plan to enter."

VPI scores and vocational choice were collected from 6,289 male freshmen at 31 diverse colleges in the spring of 1964 as described in Abe et al. (1965). In addition, the same data were collected from 12,345 male 2-year college freshmen at 66 institutions in 1968 as described in Holland et al. (1969). Follow-up data giving vocational choice nearly 1 year later was available on 3,869 males of the 1964 sample.

*The Configural Analysis*

From the correlation matrix of the six VPI scale scores given in Holland (1968, p. 36), a principal components analysis was performed. As shown in Table 1, the first three dimensions accounted for 78% of the trace. All six scales had high positive loadings on the first dimension of variability, which may represent overall checking rate on the VPI (one kind of response set). Thus, considering the three dominant dimensions, the scales lay very nearly in a plane perpendicular to the first factor. By using the factor loadings to locate the six points in six-space, the two largest characteristic vectors of the covariance matrix of the six factor scores over the six points define a plane for which the squared deviations of the points from the plane are at a

**TABLE 1**

**Principal Components Analysis of VPI Scales**

| Factors | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| Roots | 2.37 | 1.17 | 1.13 | 0.55 | 0.49 | 0.29 |
| Percent trace | 39.6 | 19.5 | 18.8 | 9.2 | 8.1 | 4.8 |
| VPI Scales | | | Loadings | | | |
| Realistic | .528 | .462 | –.541 | .000 | .463 | –.027 |
| Intellectual | .442 | .785 | .021 | –.053 | –.425 | –.063 |
| Social | .685 | –.132 | .401 | –.582 | .104 | .057 |
| Conventional | .710 | –.347 | –.454 | .096 | –.220 | .333 |
| Enterprising | .799 | –.421 | –.051 | .159 | –.076 | –.387 |
| Artistic | .537 | .153 | .680 | .421 | .167 | .141 |

minimum. When the six points in six-space are projected onto this plane, the result is a two-dimensional representation of the six points.

To locate an individual or occupational group mean profile on this plane, the factor scores are approximated, then the point in six-space is projected onto the plane.[1] This procedure is combined into one operation by premultiplying the vector $(z - \bar{r})$ by the matrix *P* given in Table 2. In this study the *z* scores were obtained by standardizing the raw VPI scores by the means and standard deviations reported in Holland (1965, p. 32).[2] The vector, $\bar{r}$, is the average of the rows (or columns) of the correlation matrix of the VPI scores.

Students with the same vocational choice were grouped together and the standardized VPI scale means for each group were projected onto the plane as described.

[1]The details of the procedure used are described in Cole and Cole (1970).

[2]VPI means and standard deviations from Holland (1965, p. 32):

| | *R* | *I* | *S* | *C* | *E* | *A* |
|---|---|---|---|---|---|---|
| Mean | 4.3 | 5.4 | 4.5 | 3.2 | 4.6 | 3.6 |
| *SD* | 3.6 | 4.3 | 3.6 | 3.5 | 3.5 | 3.7 |

**TABLE 2**

**Projection Matrix for Placing a Standardized Profile Vector onto the Plane**

| | *R* | *I* | *S* | *C* | *E* | *A* |
|---|---|---|---|---|---|---|
| *P* = | -1.269 | -0.301 | 0.879 | -0.724 | 0.118 | 1.298 |
| | 0.422 | 1.290 | -0.215 | -1.007 | -0.985 | 0.495 |

## Results

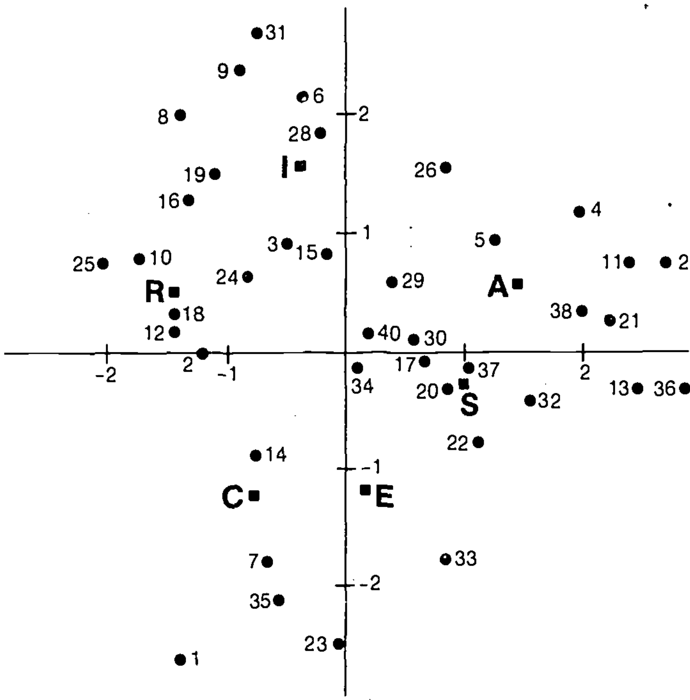
### *The Occupational Configuration*

Projection of occupational choice group VPI means onto the best-fitting plane gave a two-dimensional map of occupations showing the relationship of occupations to each other on the basis of the VPI. Occupations falling near each other are similar in the vocational interests of the students selecting them. Those falling far apart are quite different. The distance between the occupations in the configuration is a measure of their similarity or the degree to which they are related.

Forty selected occupations are mapped in Figure 1 along with the size for each group. It should be noted that occupational groups with similar titles are located close to each other. For example, note the following occupational clusters: Art (4 and 5); Agricultural Science (2) and Farming (18); and the engineering groups—Chemical (8), Civil (10), Electrical (16), and Mechanical (25). The six VPI scales are superimposed on the map to relate the configuration to Holland's system.

## Discussion

In general, the occupational configuration presented in Figure 1 has face validity in that observers usually agree that jobs placed close together are similar in many ways while those far apart are different. In addition, the configuration conforms in a general way to groupings of occupations suggested by many theorists and empiricists such as Holland (1966a), Holland et al. (1969), Roe (1958), Strong (1943), and Thorndike and Hagen (1962).




1. Accounting (279)
2. Agricultural Science (166)
3. Architecture (83)
4. Art (45)
5. Art* (179)
6. Biology (55)
7. Business Management (360)
8. Chemical Engineering (94)
9. Chemistry (87)
10. Civil Engineering (185)
11. Clinical Psychology (42)
12. Construction* (103)
13. Counseling and Guidance (36)
14. Data Processing* (502)
15. Dentistry (120)
16. Electrical Engineering (259)
17. Elementary Education (117)
18. Farming (61)
19. Forestry (105)
20. History (57)
21. Journalism* (62)
22. Law (288)
23. Marketing (45)
24. Mathematics, Statistics (80)
25. Mechanical Engineering (152)
26. Medicine (354)
27. Music (41)
28. Natural Science Education (86)
29. Photography* (100)
30. Physical Education, Rec., Health (272)
31. Physics (61)
32. Political Science (76)
33. Public Relations, Advertising (40)
34. Radio, TV* (157)
35. Sales (64)
36. Speech and Drama* (40)
37. Teaching* (739)
38. Theology (77)
39. Undecided* (824)
40. Undecided (451)

**Fig. 1.** A spatial configuration of occupations based on Vocational Preference Inventory responses of males entering 2-Year (*) and 4-year colleges (*N* in parentheses).

*Relation to Holland's Classification*

Holland (1966a, 1969) has classified individuals and occupations according to codes based on the decreasing order of VPI scale scores. There are two important ways in which the configural analysis differs from Holland's classification. First, Holland classified on the basis of raw VPI scale scores while in the configural analysis standardized scores are used. Thus, a scale with a mean score higher than other scales will appear dominant in Holland's scheme while our scheme will tend to equalize the scales.

While standardized scores could be used in the Holland system obviating the first difference, the second difference is due to a unique effect of the configural analysis. The location of a point on the plane is a simultaneous resolution of forces in the directions of the six scales. Holland selected the single largest force or ranked the forces to classify a profile.

The effect of these two differences in the two methods are illustrated by the occupation Mathematician. In Holland's scheme Mathematician is "IRCE" with Intellectual clearly dominant. When the scores are standardized, the ordering becomes ICRA and Intellectual and Conventional are nearly equally dominant. Now I and C are partially divergent interests, and the results of the configural analysis place the occupation between I and C (or near the R occupations) by resolving the forces of I and C. When occupations have divergent interest patterns, the two schemes will differ as they do on Mathematician. In the present data there were few cases of this kind of difference, however. When a profile is dominated by a single force or reinforcing forces, the two methods will yield similar results.

*Use of the Configuration to Define Some Concepts*

Several concepts used by personality and vocational choice theorists can be operationalized by measurements in the planar configuration. Several examples follow.

*Job similarity.* The degree of similarity of interests of different occupational groups can be measured by the distance between those groups on the planar configuration. The closer two occupational groups, the more similar are the interest patterns of the groups.

*Congruence of an individual and occupation.* The congruence of an individual's interests with those of others selecting his or her occupational choice is a concept often discussed. In the planar configuration, this congruence can be measured by the distance between the individual's point on the plane and that of the occupational group. When an individual falls close to the occupation, we can say his or her interests are congruent with those of people in the occupation. When far away, we can speak of incongruence.

*Stability of vocational choice.* The stability of a vocational choice over time is an important concept often measured dichotomously. When a person stays with the same occupational choice, we say his or her choice was stable. A change to another occupational choice denotes instability. However, it seems that changing from one job choice to a very similar one does not represent the same degree of instability as changing to a vastly new and different area. Therefore, the distance on the plane between an original occupational choice and a later one would seem to be a reasonable measure of stability preferable to a simple categorical measure. On the plane a small distance would denote stability and a large distance, instability.

*Differentiation of interests.* Several authors have discussed a concept perhaps most clearly described as the degree of differentiation of interests. By this we mean the degree to which a unitary interest (or reinforcing interests) dominates an interest profile. Interest in several divergent areas represents lack of differentiation as does approximately equal degrees of interest or disinterest in all areas. In the planar configuration this concept may be defined by measuring the distance of a profile point from the center of the plane. A profile with a dominant single interest or with a reinforcing interest pattern would be far from the center.[3] One with diverse interests would be resolved to near the center of the plane.

*Interest changes.* One intriguing possibility is mapping an individual's changing interests over a period of time by following the resulting points from that person's profiles on the plane. For example, if an individual becomes increasingly mature in his or her vocational exploration and decision making, his or her map may show successively decreasing between-job distances.

### *Research Applications of the Spatial Configuration*

Several hypotheses can be tested within the framework of the configural analysis by using the concepts of the preceding section. We will state two research questions and present the answers that our type of analysis gives to such questions. It should be recalled that we are measuring interests only by the VPI and that the planar configuration ignores some of the dimensions of variability in the VPI. Thus, our answers are limited by the framework in which they are posed.

1. Is the congruence of an individual's interests to those of others in his or her chosen occupation positively related to the stability of his or her vocational choice?

[3]By a reinforcing interest pattern we mean strong interests in related areas (adjacent VPI scales) and/or great lack of interest in unrelated areas (areas falling on the opposite side of the plane).

Most theorists would answer "yes" to this question. We correlated the congruence (the distance between an individual's planar point and that of the chosen occupation) with the stability of vocational choice (the distance between a student's vocational choice as a freshman and his or her choice 9-12 months later) for the 1,943 students with all needed data. The correlation found was $r$ = .454. This correlation is significantly different from zero at .001 level. Thus, it seems that congruence is positively related to stability of vocational choice.

2. Is the person with more differentiated interests likely to be more stable in his or her vocational choices?

Many theorists postulate that differentiation is related to stability. However, we correlated differentiation as measured by distance from the center of the plane with stability for the same 1,943 students and found a correlation of .043. This correlation is not even in the predicted direction. Thus, it appears some reconsideration of the postulate or of our method of defining the concept is in order.

Several items favor the postulate. First the fact that Undecided groups of students fall quite near the center of the plane would lend initial support. An artifact of the planar configuration could also help account for the low correlation. Occupations located away from the center are farther apart in general. Thus, any change may appear to be a large change for people with differentiated interests who likely select occupations away from the origin.

However, the planar configuration does raise the possibility that the postulated relationship is not of overriding importance. Consider, for example, occupations which fall near the center of the plane such as the teaching occupations. It would seem that people selecting the teaching occupations do have a variety of interests or undifferentiated interests, yet there seems little reason to expect instability of occupational choice. Perhaps the stability of vocational choice for some people is determined by their finding an occupation suitable to their undifferentiated interests. Thus, it seems that the planar configuration raises some interesting questions about the postulated relationship even though no clear answer is given.

*Discussion of Potential Applications*

There are many possible applications of the spatial configuration of occupations both in counseling and research. We have considered here two research questions and shown how the spatial configuration can be applied. Other research issues which can be explored include the way in which an individual's VPI profile point changes over time in relation to his or her occupational choice. Does he or she move closer to his or her occupational choice? The change in occupational choice over time in relation to an individual's point can be considered also. Does a person make consecutive choices which move closer to his or her interests? Further, the relationship of an individual's point to that of his or her occupational choice might be related to measures of his or her vocational maturity or job satisfaction.

If research shows consistencies in the use of individual and occupational points on the plane, then counselors can make use of the information both of occupational similarities and of an individual's location on the plane. For example, the visual occupational map could be used to show an individual where his or her interest profile falls and what occupational groups show similar interests.

While others have graphed occupations using various methods, this spatial configuration is unique in the way that it ties a visual picture of job similarities and individual interest profiles to a simple theoretical framework relating occupational interests to personality types. At the same time the occupational map accounts for a large portion of the variability of VPI scores.

The simplicity of the two-dimensional map is both its strength and weakness. The relationships of vocational interest patterns undoubtedly involve complexities unaccounted for in our configuration. At the same time, if the system proves meaningful, its simplicity will be a great asset. The VPI data yield much important information in the two-dimensional configuration. In many settings it is impossible to consider all of the complexities of occupational relationships. In those cases, this simple system which accounts for important occupational and individual differences may be most helpful.

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Chapter 4

## AN ANALYSIS OF THE STRUCTURE OF VOCATIONAL INTERESTS

*Nancy S. Cole and Gary R. Hanson*

The internal structural relationships of scales from the Strong Vocational Interest Blank, the Kuder Occupational Interest Survey, Holland's Vocational Preference Inventory, the Minnesota Vocational Interest Inventory, and the new American College Testing Program Vocational Interest Profile were compared. The configurations of the scales for all the inventories were found to be similar and to conform to the circular configurations of interest proposed by Roe and Holland. The common configuration of vocational interests was used to reconcile previous contradictory research results about the comparability of interest scores from various instruments and as a basis for counselor interpretation.

The several inventories of vocational interest used in this country were constructed in different ways, scored by different methods, and report scores on different numbers of scales with different names. However, the similarity of scale names across instruments raises the question of the

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degree to which the different inventories measure the same or similar interests.

The degree of correspondence between various inventories has been investigated by directly comparing an individual's interests as measured by various instruments. Several such studies yield apparently contradictory results. Triggs (1943, 1944) and Wittenborn, Triggs, and Feder (1943) reported similarities in the Strong Vocational Interest Blank (SVIB) and the Kuder Preference Record by considering overall profiles and correlational configurations. In more recent studies, King, Norrell, and Powers (1963), O'Shea and Harrington (1971), Wilson and Kaiser (1968), and Zytowski (1968) reported low correlations between corresponding scales of the Strong and various Kuder forms, and Kuder (1969) discussed methodological differences in construction of the instrument which could lead to low correlations. In still other comparisons, Rose and Elton (1970) and Wall, Osipow, and Ashby (1967) used intermediate variables (such as vocational choice or major field) to demonstrate the relationship between two inventories—this time the Strong, and Holland's Vocational Preference Inventory (VPI).

Although the direct approaches have produced different conclusions, many writers have proposed categories of vocational interest which indirectly suggest correspondence between inventories. Super and Crites (1962) compared the factors of interests reported in several factor analytic studies, including those of Thurstone (1931), Strong (1943), and Guilford, Christensen, Bond, and Sutton (1954). The following factors were commonly found: scientific, social, language-literary, mechanical, business, and artistic factors. Cottle (1950) and Harrington (1970) also reported correspondence of many factors of the Strong and different Kuder forms.

Many classifications of occupations have used categories which resemble the factors listed. Roe (1956) proposed eight groups (Technology, Outdoor, Science, General Cultural, Arts and Entertainment, Service, Business Contact, and Organization) in her two-way classification of occupations. Super (1957) named similar groups: Technical or Material, Scientific, Musical or Artistic, Literary, Humanistic or Social Welfare, Business Contact, and Business Detail. Further similarities are found in the families of scales of the Strong (Darley & Hagenah, 1955; Strong, 1943). Holland (1966b) described six major occupational and personality types (Realistic, Intellectual, Artistic, Social, Enterprising, and Conventional) and used the types to classify occupations (Holland, 1966a).

These classes of occupations and interests have been used primarily as discrete and independent categories. However, recent considerations of the relationships among the categories suggest a basis for the comparison of interest inventories which may help to unify previous results. Roe (Roe, 1956; Roe & Klos, 1969) suggested that her interest categories were related to each other in a circular ordering in which classes adjacent in the circle were most closely related while those most widely separated were the least related. Several studies supported the proposed continuum of interests (Jones, 1965; Roe, Hubbard, Hutchinson, & Bateman, 1966). Holland examined the relationships of the six scales of the Vocational Preference Inventory and empirically demonstrated a circular arrangement of the scales (Holland, Whitney, Cole, & Richards, 1969) from Realistic to Intellectual to Artistic to Social to Enterprising to Conventional and back to Realistic. Cole, Whitney, and Holland (1971) used a statistical analysis of spatial configuration to relate occupational groups to the six Holland scales. The results also demonstrated that the circle of Holland scales can be considered as a continuum of interests with each location in the circle representing a different mix of the six Holland interests.

The similarities of the many proposed categories of occupational interests and the recent demonstrations of relations among the categories suggest that a simple configuration or structure (such as that demonstrated by Holland) may underlie the vocational interests assessed by various inventories. If such a configuration does exist, the inventories may be sampling interests from a common underlying interest domain, and the configuration thus may provide a useful perspective for research and interpretation.

The purpose of this paper is to determine whether the circular configuration of interests proposed and demonstrated by Roe and Holland (as previously discussed) is common to other interest inventories. Since Holland's six interest categories represent one of the simplest skeletal versions of the interest categorizations, it is the basis of comparison. The following inventories were studied: the Strong Vocational Interest Blank (SVIB), the Kuder Occupational Interest Survey (Kuder OIS), Holland's Vocational Preference Inventory (VPI), the Minnesota Vocational Interest Inventory (MVII), and a new instrument, The American College Testing Program's Vocational Interest Profile (ACT VIP). If the circular arrangement is common to the internal structure of several instruments, the arrangement would provide a basis for comparisons of the instruments that might resolve the conflicting results of previous research and provide a basis for counselor interpretation.

## Method

### *The Analysis of Spatial Configuration*

Cole and Cole (1970) described an analysis of spatial configuration which used the method of principal components to examine variable relationships. This analysis, when performed on Holland's Inventory, yielded a circular configuration of the six Holland scales (Cole et al., 1971). The same analysis was applied to the Strong, the Kuder OIS, the Minnesota Inventory, and the ACT instrument to determine if the scales on each of these inventories are also arranged in a corresponding circle.

The analysis of spatial configuration uses the correlation matrix as the source of information about relationships among the variables. The geometric configuration of vectors (or points) representing variables (in this case scales of an inventory) is then reduced by fitting a smaller space to the vector points. If the variables lie predominately in a smaller space, then the relationships among the variables may be more easily understood. Often, in practice, the smaller space is two dimensional (a plane) and the variables may be plotted and visually represented as in the analysis of Holland's instrument.

Two results of the configural analysis are of special importance to our considerations. The first is the degree to which the relations among the scales on an interest inventory may be represented by a plane and the second is the particular arrangement of the scales in that plane. The percentage of the trace for the first two components of the second stage analysis (Cole & Cole, 1970, p. 3) can be interpreted as indicating the percentage of the variance of the scale points accounted for by the fit of the plane. The projection of the interest scales onto the plane (Cole & Cole, 1970, p. 4) provides the particular scale configuration.

*Comparisons of Configurations*

In order to compare the planar configuration of one instrument with that of another, differences in types and numbers of scales used in the instruments must be accommodated. Holland's simple system of six categories, which is similar in many ways to other categorizations and has the circular configuration under consideration, is used as the basis of comparison. Scales of the Strong and the Kuder were classified into Holland's system on the basis of a classification of 400 occupations reported in Holland, Viernstein, Kuo, Karweit, and Blum (1970). (Scales without a corresponding classification in that report were left unclassified.) Then the positions in the configural analysis for all the scales in each Holland class were averaged, resulting in mean planar locations representing the six Holland categories. These mean planar points could then be examined for indication of the circular configuration in the Holland ordering.

*Data*

Separate correlation matrices of the scales in each of the interest inventories were submitted to the analysis described. The intercorrelations of 50 SVIB occupational scales for 301 men were reported in Campbell (1966, pp. 37-39); those for the 22 SVIB basic scales for 647 men were found in Campbell, Borgen, Eastes, Johansson, and Peterson (1967, p. 49). *The Kuder Occupational Interest Survey Manual* (Kuder, 1966, pp. 58-59) gave the intercorrelations of the 23 core scales for 276 men. Intercorrelations of the nine homogeneous keys of the Minnesota Inventory for 400 men were obtained from Clark (1961, p. 65). The intercorrelations of the 12 scales of the ACT instrument for 311 male students are given in the *Handbook for the ACT Career Planning Profile* (The American College Testing Program, 1970). The analysis of a correlation matrix for men on Holland's inventory was adapted from Cole et al. (1971) in order to facilitate comparisons with the other inventories.

## Results

### *Goodness of Fit of the Planes*

The goodness of fit of a planar surface to the points representing the scales of an inventory was measured by the percentage of the trace given by the first two dimensions. Table 1 gives the results for the fit of the plane for each of the inventories considered. The percentage of the trace may be interpreted as the proportion of variance of the scale points accounted for by the two dimensions.

The planar configuration accounted for over half (between 56% and 64%) of the variance in the scale points for four of the inventories while the SVIB

**TABLE 1**

**Goodness of Fit of the Planes**

| *No. of scales* | *Instrument* | *Percentage trace accounted for by the plane* |
|---|---|---|
| 6 | Holland's VPI Scales | 63.7% |
| 50 | SVIB Occupational Scales | 56.4% |
| 22 | SVIB Basic Scales | 37.8% |
| 23 | Kuder OIS Core Scales | 60.7% |
| 9 | MVII Homogeneous Keys | 58.2% |
| 12 | ACT VIP Scales | 47.3% |

basic scales gave the poorest fit. Since the basic scales were constructed to be as nearly independent as possible, this poorer planar fit is not surprising. Two dimensions do not offer a complete representation of the internal structure of any of the inventories. However, the percentages near 50% and higher are substantial for instruments having many factors and, supposedly, great complexity.

*The Planar Configurations*

The scale points were projected onto the best-fitting planar surface for each of the inventories. Since the location of the principal component axes is of no special interest in this configural analysis, the planar configurations have been oriented in the same general way for each inventory to simplify visual comparisons.

Figure 1 gives the configuration of Holland's six scales as reported in Cole et al. (1971). The circular configuration in the Realistic-Intellectual-Artistic-Social-Enterprising-Conventional ordering is apparent.

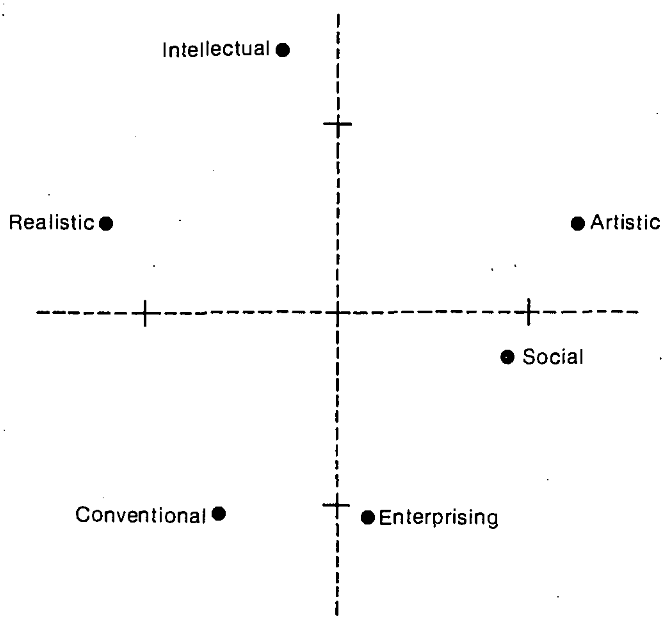


**Fig. 1.** Spatial configuration of Holland's six Vocational Preference Inventory scales.

The Strong occupational scales, the Strong basic scales, and the Kuder scales are given in Figures 2, 3, and 4. Those configurations invite comparison not only with Holland's categories but also with the configuration of occupations derived on the basis of the means on Holland's inventory for occupational groups and reported in Cole et al. (1971). The locations of corresponding scales (of the Strong and the Kuder) and occupational groups (based on Holland's instrument) are, in general, comparable. For example, Farmer, Forest Service, and Engineer scales on the Strong are located close to each other in Figure 2 as are Agriculture, Mechanical, and Technical Supervision in Figure 3, Electrical Engineer and Engineering: Heating/Air Conditioning of the Kuder in Figure 4, and Farming, Forestry, and Engineering in the Cole configuration. Other similar

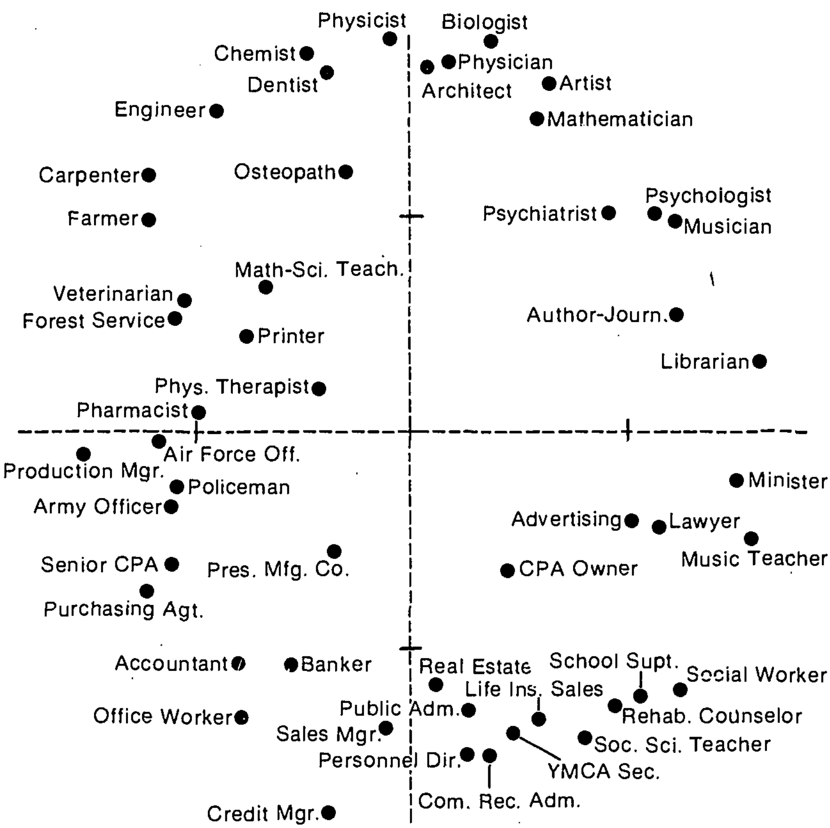


**Fig. 2.** Spatial configuration of 50 Strong Vocational Interest Blank occupational scales.

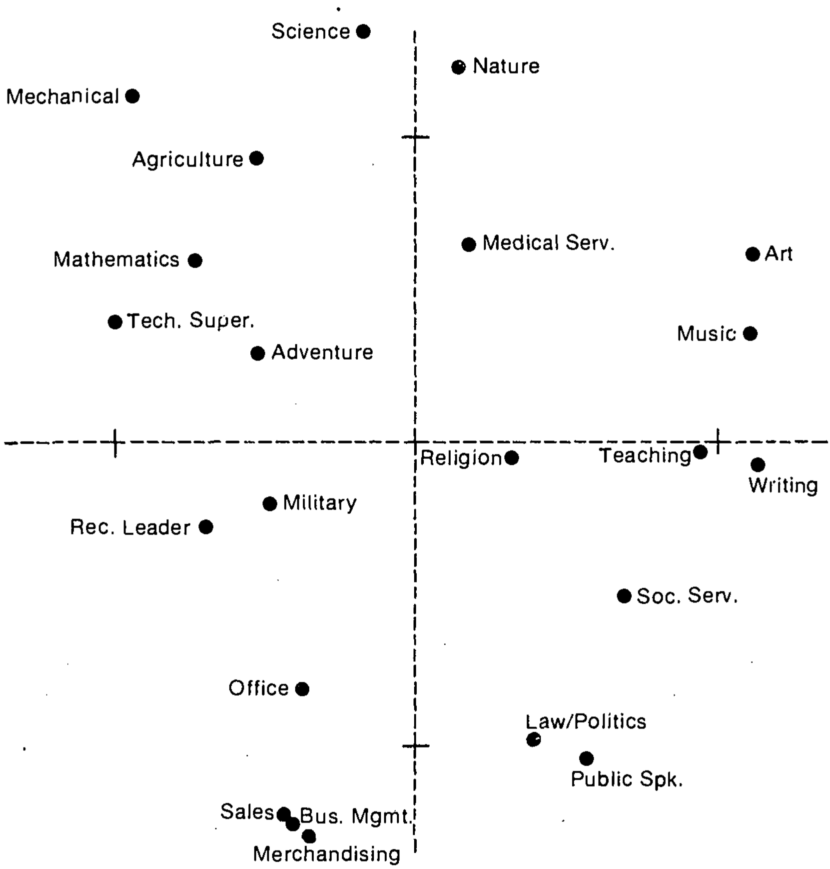


**Fig. 3.** Spatial configuration of the 22 Strong Vocational Interest Blank basic scales.

groupings correspond to the other Holland categories just as those mentioned correspond to the Realistic category. Not only are there similar clusters of occupations, but also similar relationships of the clusters to each other which correspond basically to the Holland circular ordering.

The configuration of the Minnesota Inventory is given in Figure 5 and that of the ACT Vocational Interest Profile in Figure 6. Both inventories are oriented to technical occupations and therefore the technical side of the circle is expanded. In both cases, Carpentry, Mechanical, and Electronics for the Minnesota Inventory, and Carpentry, Mechanical, and Electrical for

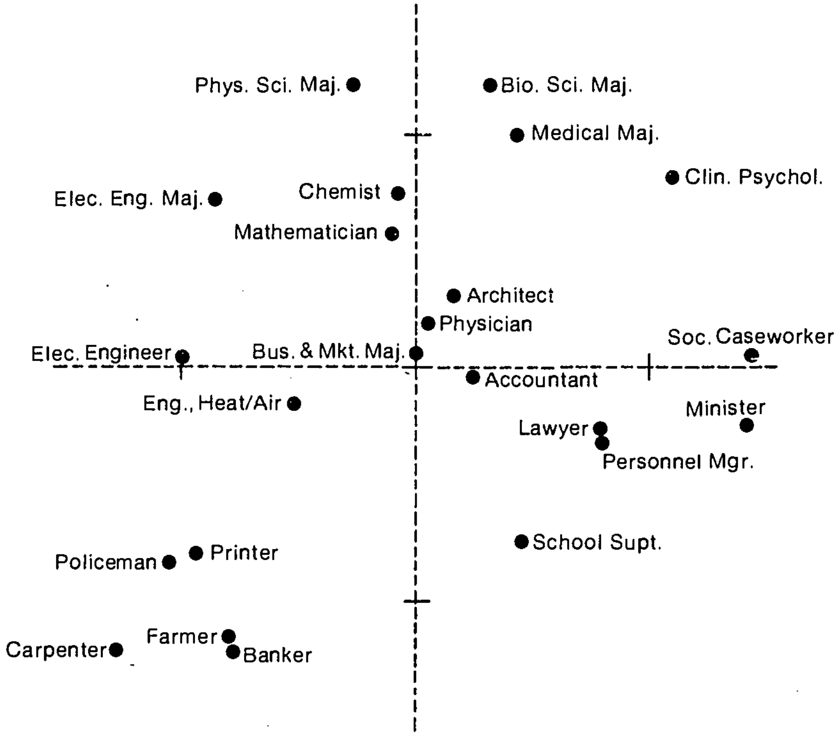


**Fig. 4.** Spatial configuration of the 23 Kuder Occupational Interest Survey core scales.

the ACT instrument maintain the same ordering, the ordering also reported by Cole et al. (1971) for Construction, Mechanical Engineering, and Electrical Engineering. Similarly, Health Service of the Minnesota Inventory and Health of the ACT instrument fall in the same general area of each configuration as do the Business scales (Sales—Office, "Clean Hands," and Office Work) of the MVII and the Business scales of the ACT VIP.

*Comparison of Configurations*

Only the Strong and the Kuder have enough scales corresponding to occupations classified by Holland et al. (1970) to group the scales into the six Holland categories. Figure 7 gives the mean planar location for each category. The mean locations are connected by lines in the order under investigation. If lines were drawn from the center of the configuration to

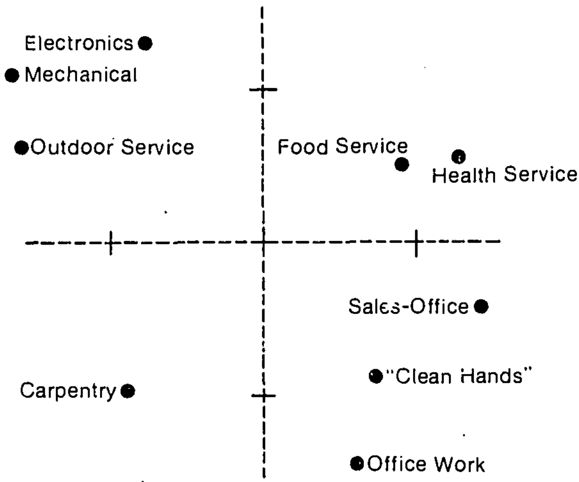


**Fig. 5.** Spatial configuration of the Minnesota Vocational Interest Inventory homogeneous keys.

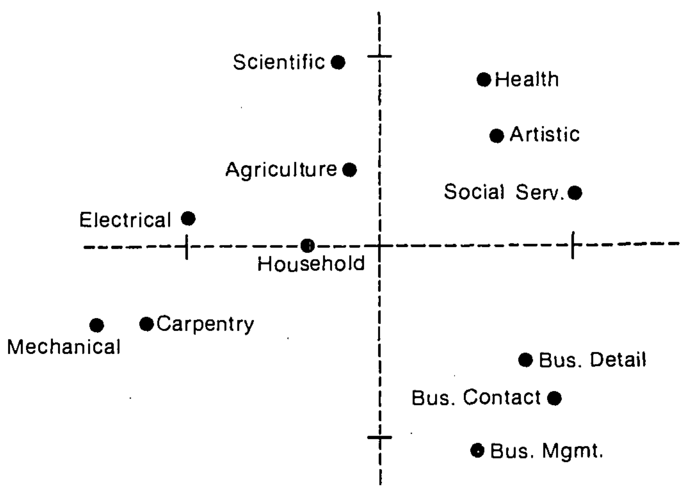


**Fig. 6.** Spatial configuration of the 12 American College Testing Program Vocational Interest Profile scales.

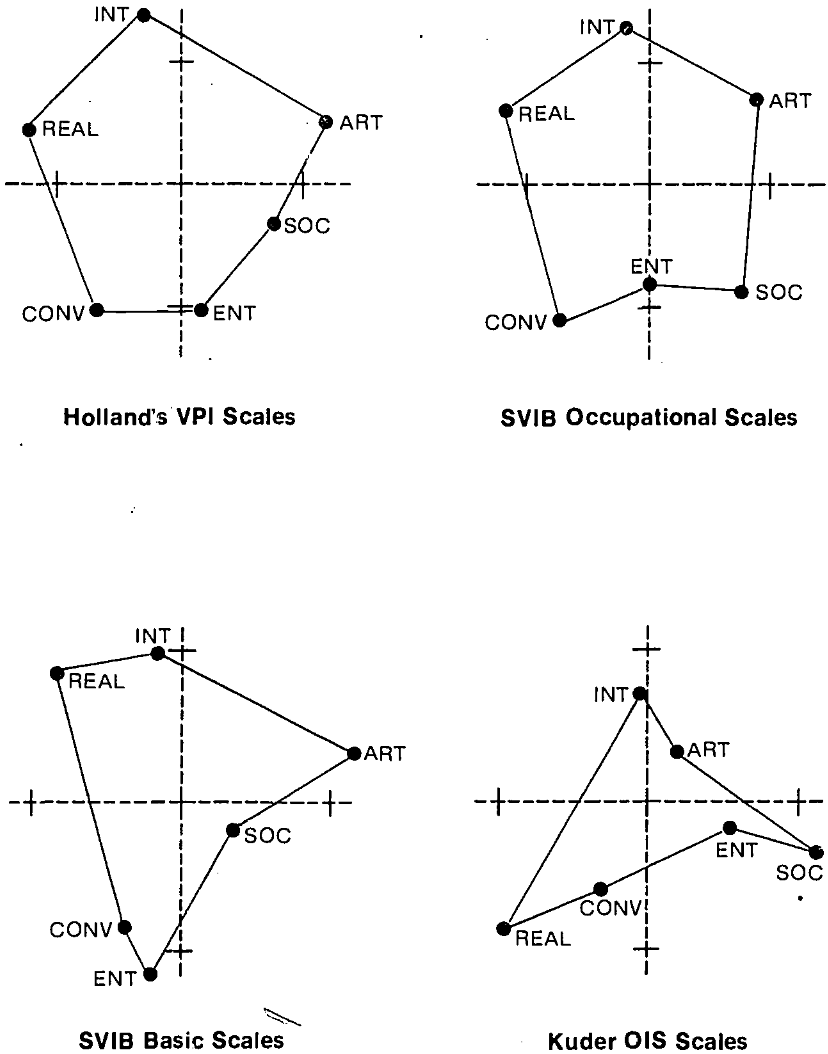


**Fig. 7.** Comparison of the spatial configuration of the Strong Vocational Interest Blank (SVIB) and the Kuder Occupational Interest Survey (OIS) with Holland's Vocational Preference Inventory (VPI) using scales categorized by Holland's classification. (Abbreviations: REAL = realistic, INT = intellectual, ART = artistic, SOC = social, ENT = enterprising, CONV = conventional.

each mean location, in each case the ordering of these lines would duplicate the Realistic-Intellectual-Artistic-Social-Enterprising-Conventional ordering. Thus, the results in Figure 7 confirm the circular ordering already reported in connection with the individual scales.

## Discussion

The purpose of this study was to examine the degree to which Holland's circular configuration of interests is common to various inventories. The results of the analysis of spatial configuration provide answers to two basic questions. The first question is: To what extent can the relationships among the scales be described in a plane (in two dimensions)? The answer, provided by the goodness of fit of the planes, is that the interrelations among the scales can be described to a large and important degree by two dimensions. The second question is: To what extent are the particular planar configurations of scales common from one instrument to another? Investigation of the configurations demonstrates that Holland's (and Roe's) configuration is, to a large degree, common to all the instruments investigated. This second result would have been an important finding even if present only on less dominant dimensions. That the circular configuration always appeared on the first two dimensions of variation among the scale points and that these two dimensions accounted for a large part of variation provide even stronger evidence for the practical importance of the circular ordering of interests.

### *Relation to Previous Research*

A related purpose of the study was to use the results about the configuration of the scales to help reconcile the conflicting results of previous research. The demonstration of a common, underlying, circular ordering of vocational interest scales for several instruments provides a new basis for comparison of different inventories which may make the results of previous studies more understandable.

In one group of previous studies low correlations on same-named or similarly named scales were reported and it was concluded that the inventories measured very different things. However, a new look at the results of these studies using the common configuration of interests provides evidence of great similarities between instruments. Table 3 of King et al. (1963, pp. 398-399) presented a list of Strong scales with which a particular Kuder, Form D, scale correlated more highly than it did with a similarly named Strong scale (and vice versa). For example, the Kuder-D Physician scale correlated more highly with the SVIB Psychologist scale than it did with the SVIB Physician. The SVIB Physician scale correlated more highly with the Kuder-D Meteorologist, Pediatrician, High School

Science Teacher, and Chemist scales than with the Kuder-D Physician scale. If each scale in Table 3 of King et al. is categorized into one of the Holland et al. (1970) categories, then in almost every case the listed scales conform to the same Holland category or an adjacent one. Similar results are found in the few examples given by O'Shea and Harrington (1971). Thus, by reinterpreting results on the basis of the circular configuration, the overall correspondence of the Strong and Kuder scales is clear even though the correspondence of particular individual scales may be small.

In a second group of studies (Triggs, 1943, 1944; and Wittenborn et al., 1943) a general correspondence between inventories was reported. In those studies the use of patterns of profiles or patterns of correlations as the bases for comparison meant that many aspects of the circular configuration were being implicitly used. Thus the results provided evidence for similarities between the inventories. Similarly the factor analytic studies, using correlational configurations, usually demonstrated similarities.

Although the comparisons of the present study were indirect in the sense that correlation matrices for different groups were used, reconsideration of the results of studies making direct comparisons provides confirmation of the direct relation of one instrument's circular configuration to that of another. That is, those scales of Interest Inventory A that fall into one of Holland's categories, as a whole, tend to correlate most highly with the scales of Inventory B that fall into the same category. Furthermore, the scales in an adjacent category (in the circular ordering) tend to provide the next highest correlations.

*Implications for Counseling*

Since much research on comparing interest inventories has been motivated by counselors who were frustrated and confused by contradictory results, consideration of the relevance of these findings to counseling practice is appropriate. The results of this study have implications for the interpretation of scores from a single inventory as well as for comparison of scores from more than one inventory. By using the circular structure, a counselor may determine patterns of interest by observing scores on groups of scales rather than considering scales individually. For example, a person's high scores on scales such as Farmer, Carpenter, Forester, and Engineer together indicate Realistic interests which may be applicable to many other occupations. These results also suggest that correspondence of the scores on two or more interest inventories can best be determined by considering patterns of scales rather than individual scales. If a person scores high on several Intellectual scales on one instrument, he will likely score high on Intellectual scales on another. However, he may be highest on Chemist on one instrument and on Physicist on the other.

The discrepancies that occur in the comparison of scores on similarly named scales of different instruments deserve further consideration. This study suggests some reasons for the discrepancies which may be helpful to counselors. Most occupational titles. such as engineer, physician, lawyer, and salesman, do not represent narrowly defined occupations. Instead many different types of activity occur under the same occupational title. The activities of an engineer may range from building bridges to teaching electrical engineering. While the activities have common aspects and reflect many common interests, in the Holland scheme the bridge builder represents almost typical Realistic interests while the electrical engineering professor combines Intellectual interests with the Realistic ones. Similarly, the physician may be a pediatrician or a surgeon. Both share the Intellectual interests common to all physicians but the pediatrician likely reflects strong Social interests as well as Intellectual interests and the surgeon, Realistic interests. If we consider the circular structure of interests, we can better understand why a scale based on one physician group (composed of pediatricians) would correlate more highly with a teacher scale, say, than with another physician scale (based on surgeons). Thus, the circular configuration of interests provides a possible explanation for differences in performance on scales having the same name but possibly based on groups reflecting somewhat different vocational interests.

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# ON MEASURING THE VOCATIONAL INTERESTS OF WOMEN

*Nancy S. Cole*

Analyses of the interrelationships of scales on common interest inventories and of the interest patterns of women selecting various occupations support the similarity of the structure of women's interests to the structure previously found for men. This information should be used to provide women with information about more diverse career options than are now commonly available.

The application of civil rights laws to discrimination against women in hiring practices and in salary levels, the public attention gained by the women's liberation movement, and the increasing number of women who enter the work force each year seem to be combining to produce a large number of women with access to a greatly increasing variety of careers. Vocational interest inventories that often have been constructed primarily for use with men are used commonly to assist women in making career decisions. However, the investigation of such use necessarily has been limited to the occupations that women have entered in great numbers, traditional women's occupations. The appropriateness of present inventories for use with women who have access to the whole range of occupations should be examined carefully.

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Research has suggested that present inventories yield much meaningful information about women's vocational interests. A number of studies have reported similar differences between career-oriented and home-oriented women (Astin, 1968; Gysbers, Johnston, & Gust, 1968; Harmon, 1970; Hoyt & Kennedy, 1958; Rand, 1968; Schissel, 1968; Surette, 1967; Wagman, 1966). Astin (1968) and Harmon (1970) have studied the development of vocational interests in women using standard inventories, and Harmon (1969) examined the long-term stability of interest measures for women. Many occupational scales for women have been validated (e.g., Campbell & Soliman, 1968; Darley & Hagenah, 1955; Harmon & Campbell, 1968; Strong, 1943). Much useful information about women's vocational interests is provided by present inventories.

However, a number of questions remain about the use of present inventories with women considering vocations not traditionally associated with women. When the results of inventories center around women's occupational scales that have been limited to traditional women's occupations, students and counselors may limit consideration to the occupations presented, although, in fact, the options may be much broader. If the patterns and interrelationships of women's interests are similar to those for men, inferences may be possible from data for women to the entire range of men's occupations, thus eliminating the limiting effect of using only the traditional women's vocations. The purpose of this paper is to consider this possibility by examining the structure of women's interests in terms of inventory scales and occupational groups, to compare this structure with that for men, and finally, to suggest what inferences can be made from women's interests to the entire career spectrum.

## Study 1: Structure of Women's Interest

In a recent article, Cole and Hanson (1971) examined the structure of vocational interests of men in several interest inventories. Their results indicated a common structure (or pattern of interrelationships) of interests across all the inventories considered. The common structure followed the two-dimensional circular arrangement of scales proposed by Roe (1956) and Holland, Whitney, Cole, and Richards (1969). In Holland's terms, the circular arrangement is from Realistic to Intellectual to Artistic to Social to Enterprising to Conventional and back to Realistic.

Cole and Hanson (1971) suggested that knowledge of such a circular arrangement could assist in the interpretation of the inventories, particularly with occupations for which no specific scales exist. In the case of women, useful interpretation in the absence of particular occupational scales could be useful in this time of vocational transition. Therefore, the

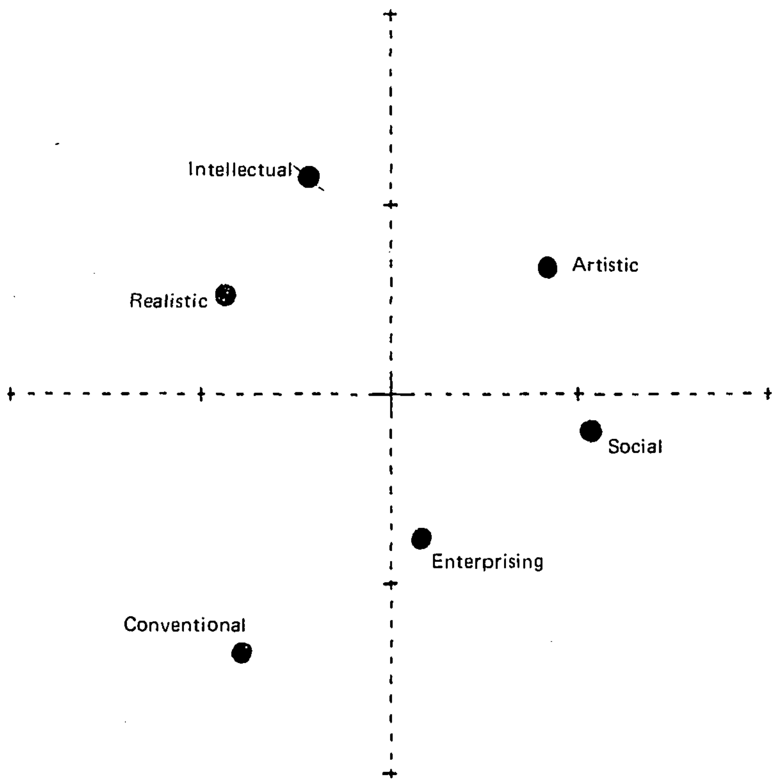


**Fig. 1.** Spatial configuration for women of Holland's six Vocational Preference Inventory scales.

purpose of the first study was to examine the structure of women's interests in the Strong Vocational Interest Blank, the Kuder Occupational Interest Survey, Holland's Vocational Preference Inventory, and the American College Testing (ACT) Vocational Interest Profile to discover if a common structure existed and, if so, to explore how it compared with that for men.

*Method*

*The analysis of spatial configuration.* Following Cole and Hanson (1971), an analysis of spatial configuration (Cole & Cole, 1970) was used to examine the relationship of scales for women in the four inventories, the Strong, the

Kuder, Holland's inventory, and the ACT instrument. The analysis gave (a) the degree to which the variation on the scales can be accounted for by a two-dimensional configuration of the scales and (b) the particular configuration of the interest scales when plotted on a two-dimensional surface.

*Data.* Separate correlation matrices of the scales in each of the interest inventories were submitted to the analysis described. The intercorrelations of 27 Strong Occupational scales for 300 women were given in Strong (1959), and those for 19 Strong Basic scales for women were taken from Campbell (1971, p. 168). The *Kuder Occupational Interest Survey Manual* (Kuder, 1966, pp. 56-57) gave intercorrelations of 21 core scales for 280 women. The intercorrelations of the six Holland scales for 2,433 women were reported in the *ACT Guidance Profile Manual* (American College Testing Program, 1968) and those for the 8 scales of the ACT inventory for 655 women were given in the *Handbook for the ACT Career Planning Program* (American College Testing Program, 1972).

The Kuder inventory posed a special problem as the 21 core scales on which data were reported for women included 14 scales constructed on men but scored for women along with 7 scales constructed on women. In addition, of the 14 men's scales, there were 9 occupational groups and 5 groups of educational majors, while 2 of the 7 women's scales also were educational majors. The 7 women's scales were traditional women's occupational areas, primarily of the social type that would be expected to give only a small segment of the Holland circle. Because of this unusual mix of scales and because comparisons across scales derived on different sex groups is not recommended on the Kuder, only the 9 male-constructed Occupational scales were analyzed. These scales seemed most likely to show any whole circle configuration that might exist.

### *Results*

*Goodness of fit of the two dimensions.* The goodness of fit of a planar surface to the points representing scales of an inventory was measured by the percentage of the trace given by the first two dimensions in the analysis of spatial configuration. The percentage of the trace may be interpreted as the proportion of the variance of the scale points accounted for by two dimensions.

Table 1 presents the results for the fit of the plane for each of the five analyses. The results were comparable to those found with men by Cole and Hanson (1971) in each case. Four of the five analyses indicated a good fit of the scale configuration to the plane with percentages of the trace near 60%. The Strong Basic scales give a much poorer fit (as occurred with men) as was expected since the scales were constructed to be as independent as possible.

**TABLE 1**

**Goodness of Fit of the Planes**

| *Number of scales* | *Inventory* | *Percentage trace* |
|---|---|---|
| 27 | Strong Occupational Scales | 59.0 |
| 19 | Strong Basic Scales | 34.3 |
| 9 | Kuder Occupational Scales | 61.7 |
| 6 | Holland's VPI Scales | 59.7 |
| 8 | ACT VIP Scales | 59.5 |

*Planar configurations.* The scale points were projected onto the best-fitting planar surface for each of the inventories, and the configurations were oriented in the same general way for visual comparisons. Figure 1 gives the configuration of Holland's six scales. The configuration corresponded to that reported by Holland et al. (1969) and Edwards and Whitney (1971) and showed the circular ordering from Realistic to Intellectual to Artistic to Social to Enterprising to Conventional.

The configurations of the 27 Strong Occupational scales, the 19 Strong Basic scales, the 9 Kuder scales, and the 8 ACT scales are given in Figures 2, 3, 4, and 5, respectively. In each case the configurations tended to follow the Holland ordering and were, in addition, similar to the comparable configurations for men reported in Cole and Hanson (1971). For example, of the Strong Occupational scales in Figure 2, math-science teacher, dentist, physician, psychologist, author, life insurance salesman, and office worker were located in positions similar to the corresponding scales for men (Cole & Hanson, 1971, p. 481); and in both cases, the scales conformed to the Holland circular ordering. For each inventory examined, the Realistic and Intellectual scales tended to be found in the upper left quadrant, the Artistic scales to the upper right, and the Social, Enterprising, and Conventional scales from right to left in the lower half of the configuration.

*Discussion*

In this study we found that women's interests can be represented in a two-dimensional configuration and that the configurations generally conform to those reported by Cole and Hanson (1971) for men. The existence of a structure in the interests of women similar to that found for men could be valuable in interpreting women's interests, especially in cases where specific scales for women in careers dominated by men are unavailable.

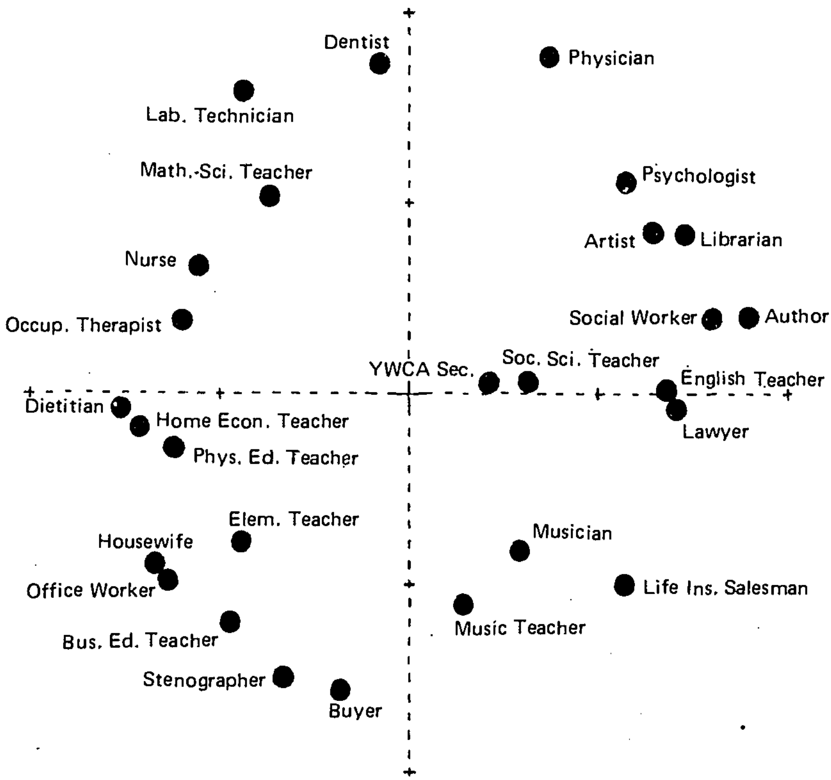


**Fig. 2.** Spatial configuration for women of 27 Strong Vocational Interest Blank Occupational scales.

In Study 2, we examined interest inventory scores of women selecting particular vocations to get further information about the pervasiveness of the Holland configuration in the vocational interests of women.

### Study 2: Occupational Configurations

Additional information about the interest patterns of women in a variety of occupations can be obtained by constructing occupational configurations. Cole, Whitney, and Holland (1971) used the analysis of spatial configuration to construct a configuration of occupations for men based on Holland's VPI.

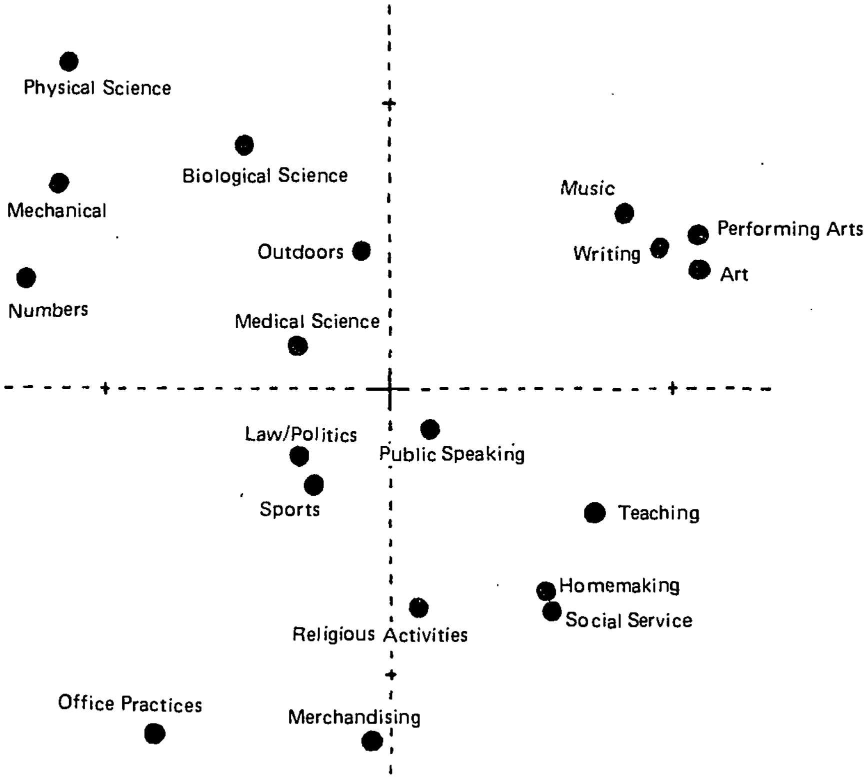


**Fig. 3.** Spatial configuration for women of 19 SVIB Basic scales.

The results both confirmed and supplemented the analyses of Cole and Hanson (1971). In this study, we constructed two occupational configurations for women—one based on Holland's VPI and one based on the ACT VIP—in order to compare the occupational configurations with the inventory scale configurations and to gain additional information about occupational groups for which no scales are available.

*Method*

*Data.* The data for one of the occupational configurations were scores on the six scales of Holland's VPI and expressed vocational choice of 6,143

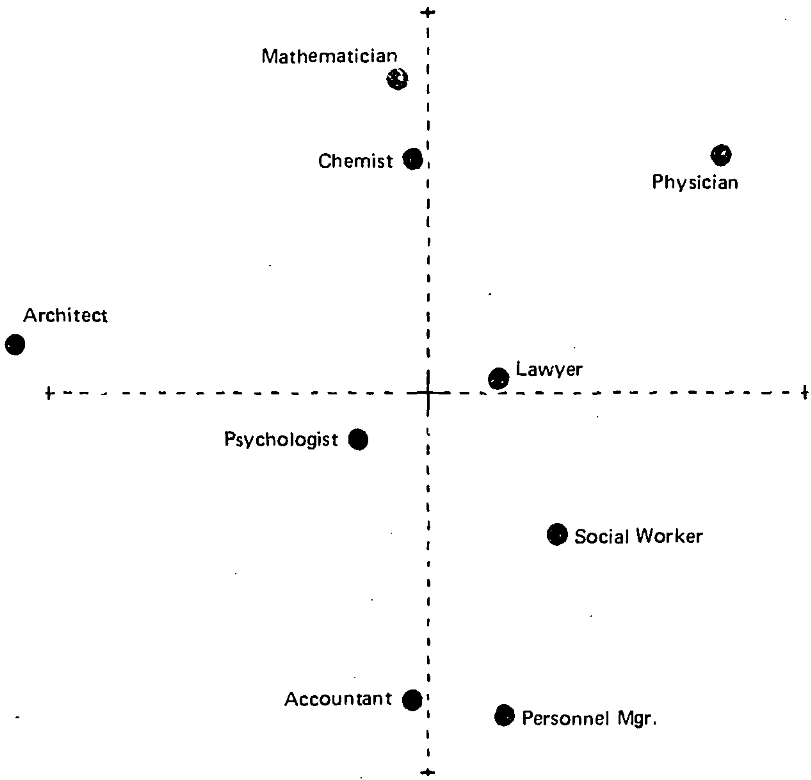


**Fig. 4.** Spatial configuration for women of nine Kuder Occupational Interest Survey scales.

female college freshmen in a sample described by Abe, Holland, Lutz, and Richards (1965). Expressed vocational choice was obtained by asking the students to select from a list of over 70 occupations "the occupation you plan to enter." Mean VPI scores were computed for all students selecting each of 22 occupations with adequate frequency of selection and expected diversity in the configuration.

For the second occupational configuration, the data were scores on the eight scales of the ACT VIP and expressed vocational choice for women entering 2-year colleges. The students selected their vocational choices

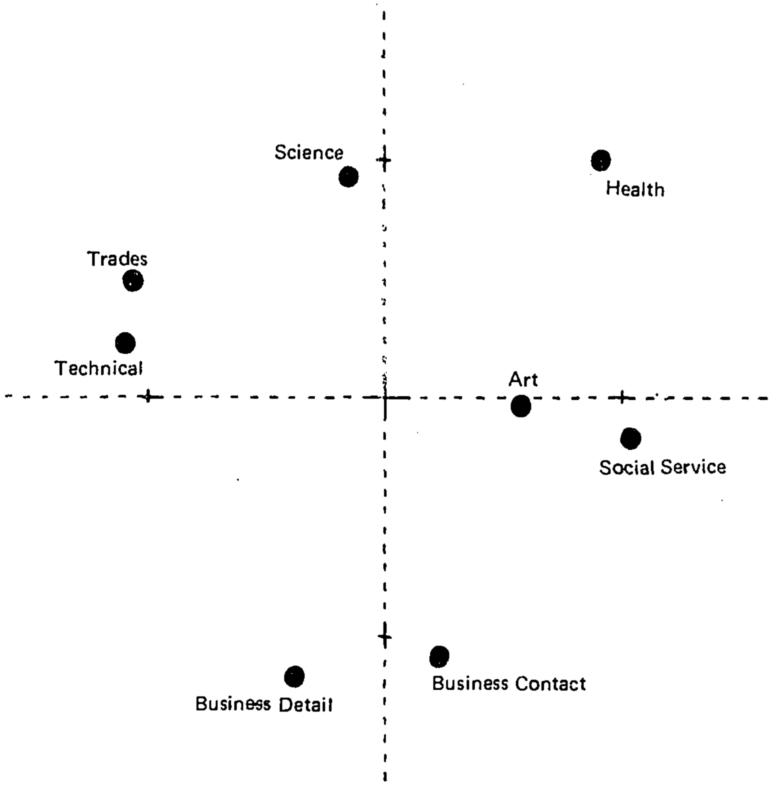


**Fig. 5.** Spatial configuration for women of eight American College Testing Vocational Interest Profile scales.

from a list of over 150 occupations. Mean ACT VIP scores were computed for students selecting each of 13 occupations.

*Analysis.* Cole and Cole (1970) described a procedure for projecting group means onto the space of the variables produced from the analysis of spatial configuration described in Study 1. The analysis yields a projection matrix with which the occupational group means can be plotted on the same surface as the scale configuration. The result is then a configuration of occupational groups. This procedure was used by Cole et al. (1971) to obtain an occupational configuration for men based on scores on Holland's

VPI. In this study the analysis was applied to data for women from Holland's inventory and from the ACT VIP to obtain two occupational configurations for women.

*Results*

Figure 6 gives the occupational map for 22 women's vocational choice groups based on Holland's VPI. The map in Figure 6 can be superimposed on that of the Holland scales in Figure 1 to relate the inventory scales and the occupational groups. The configuration in Figure 6 was compatible with the scale configuration in Figure 1; that is, social-type occupations such as social worker, elementary school teacher, history teacher, and counselor fell in the same area as the Social scale. In addition, the configuration of occupations was similar to that found for men by Cole et al. (1971).

In Figure 7, the configuration is given for 13 occupational choice groups based on the ACT VIP scores of a sample of women entering 2-year colleges. No scientific occupations were available on this group and therefore the upper left quadrant is vacant. However, even on this different sample of women, the occupations again conformed to the scale configuration in Figure 4 and to the general Holland circular ordering.

*Discussion*

The similarities of the occupational configurations based on two samples of women (one sample of 4-year college students and another of 2-year college students) and two different inventories lend further support for the pervasiveness of the Holland circular ordering in the vocational interests of women.

## Implications and Conclusions

The primary concern of this article has been to determine how interest inventories can be used with women in order to provide useful information about the full range of careers currently being opened to them. As was noted earlier, the use of traditional women's occupational scales may have a severely limiting effect on the careers women consider. Yet at this time of transition, the only data available are those on traditional women's occupations. In this section we examine the implications of the studies presented here for a different kind of use of present interest inventories with women with newly increased career options.

The two studies in this article indicated that when women's interests were compared with those of other women, the resulting structure of interests was essentially the same as that found for men. In addition, when there were

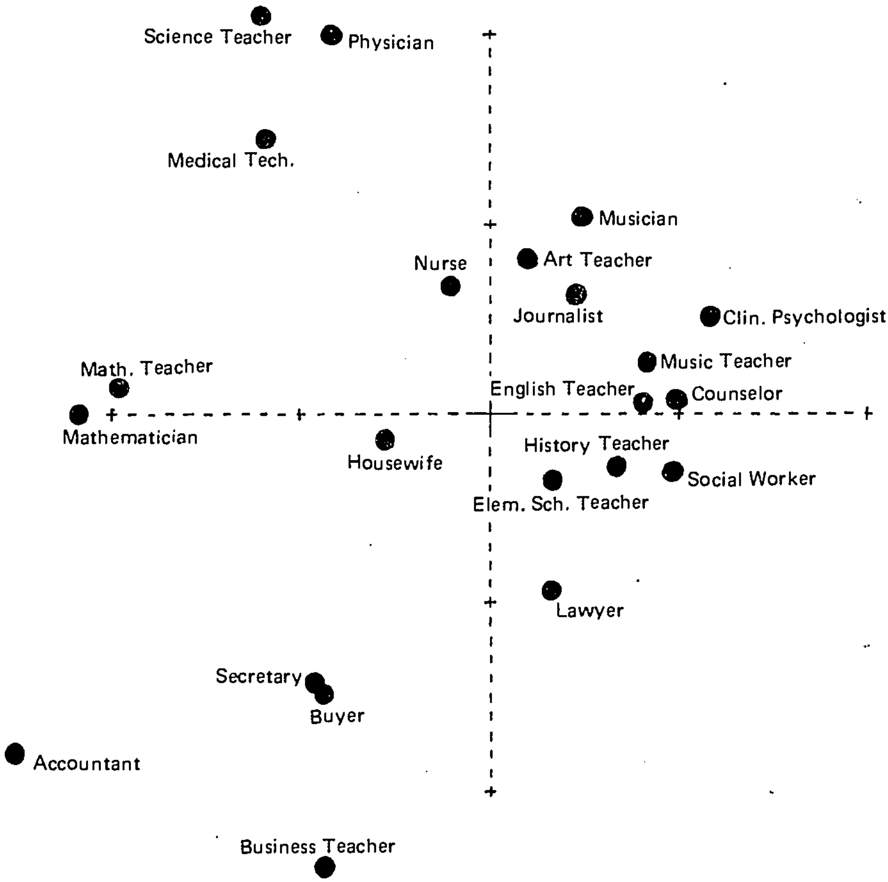


**Fig. 6.** Spatial configuration of occupations based on women's responses to Holland's Vocational Preference Inventory. (The number in each occupational group is given below.)

| | |
|---|---|
| Accountant—174 | Lawyer—32 |
| Art Teacher—93 | Mathematician—54 |
| Business Teacher—89 | Math Teacher—114 |
| Buyer—55 | Medical Technician—111 |
| Clinical Psychologist—48 | Musician—43 |
| Counselor—76 | Music Teacher—74 |
| Elementary School Teacher—1497 | Nurse—301 |
| English Teacher—306 | Physician—79 |
| History Teacher—154 | Science Teacher—45 |
| Housewife—122 | Secretary—267 |
| Journalist—57 | Social Worker—140 |

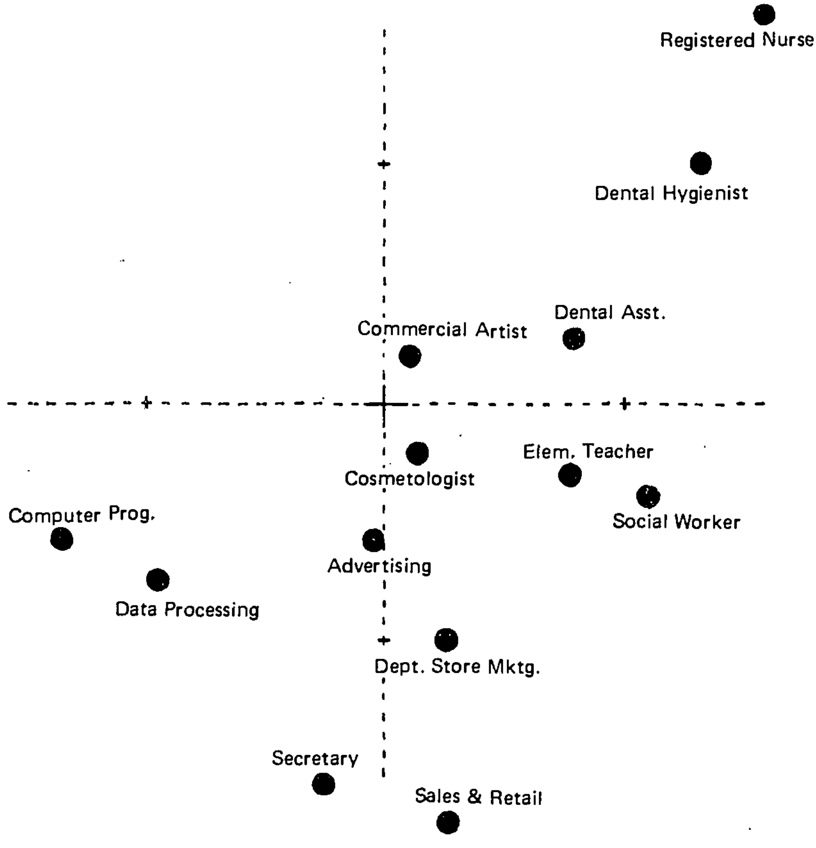


**Fig. 7.** Spatial configuration of occupations based on women's responses to the ACT Vocational Interest Profile. (The number in each occupational group is given below.)

Advertising—20
Commercial Artist—38
Computer Programmer—178
Cosmetologist—158
Data Processing—231
Dental Assistant—313
Dental Hygienist—129
Department Store Marketing—22
Elementary School Teacher—89
Registered Nurse—843
Sales & Retail—79
Secretary—988
Social Worker—58

occupations that both men and women pursue, these occupations tended to fit in similar positions within the structure for both men and women. These results suggested that by locating a woman's interests within the observed circular structure, one could indicate similarities not only with the locations of women's occupations but also with men's occupations at a corresponding location in the structure for men.

The Holland VPI and the ACT VIP are well suited to this approach since they contain scales that refer to areas of the circular structure and are identical for men and women. Thus, on these two inventories one need only identify the scales on which a woman's scores are relatively high when compared with scores of other women, and refer the woman to both the men's and women's occupations that relate to those scales.

The same type of information also is available in the Strong and in the Kuder, although in a less direct way. For these two inventories, the present scales should be used *only* to locate a woman's interests on the circular structure or in the primary categories of the structure. Then lists of both men's and women's occupations that relate to that location should be provided. On the Strong, either the women's Occupational scales, the women's Basic scales, or the new Strong-Holland scales could be used at the initial step. The women's Occupational scales on the Kuder are so limited that the male-derived scales are probably better suited for the purpose of locating women's interests on the circular structure.

Two additional implications should be mentioned. First, the procedures suggested here are different from the tradition of empirical group comparison common to both the Strong and the Kuder (although not inconsistent with the more recent work on the more general Strong Basic scales). We do not necessarily argue against the empirical approach but the lack of available data should not be used to limit women's career options, especially when a viable alternative exists. A second point deserving notice is that the results of the studies presented here do not imply that women's and men's interests do not differ. In fact, there is abundant evidence that distinct differences do exist in present society. The results imply instead that the interrelationships of interests do not differ and, for example, that a woman whose interests are relatively more scientific than those of other women may look more like a scientist in her interest pattern even though she may still have the high social interests of most women.

In summary, while present interest inventories sometimes include traditional women's occupational scales that could limit women's career options, the present inventories show a common structure of women's interests that parallels that found for men. By using this structure, women may be given information about how their interests relate to the full spectrum of occupations, including those associated traditionally with either men or women.

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Chapter 6

# THE VOCATIONAL INTERESTS OF STUDENTS IN CAREER-ORIENTED EDUCATIONAL PROGRAMS

*Gary R. Hanson and Dale J. Prediger*

The purpose of this study was to determine if the eight ACT Vocational Interest Profile (VIP) scales would differentiate among students enrolled in various career-oriented educational programs and whether the scales could be used to accurately classify students into the educational program in which they were progressing. A secondary objective was to examine whether the interest structure proposed by Holland et. al. (1969) applies to career-oriented students. Results of discriminant analyses using the eight VIP scales and applied to 501 women and 629 men suggested a high degree of program differentiation as well as moderate to good accuracy of classification. An analysis of spatial configuration confirmed the circular interest structure of the eight VIP scales when used with career-oriented students. Implications of the results were discussed in terms of the usefulness of the VIP scales with career-oriented students.

Recognition of the importance of career education in our society has been accompanied by a dramatic increase in the number of students seeking career education programs. Institutions providing these programs are faced with the responsibility of assisting students both in the transition to post-high school education and to the world of work. The diversity of career-oriented students and the educational programs in which they enroll present a special challenge to counselors and educators willing to help these students understand themselves in the context of this diversity and assist them in the identification and pursuit of appropriate career objectives.

While career decision making is an ongoing process not limited to any one stage of life, entry into postsecondary education demands that major career decisions be made, only if tentatively. Because information is a necessary, if not sufficient, condition for decision making, any information which facilitates the career decision process at this transition point will, hopefully, be made available to students.

Measures of vocational interests traditionally have been used to assist students in exploring career options. The usefulness of vocational interest measures with career-oriented students rests on at least the following three interrelated considerations. First, groups of students entering different career-oriented educational programs should be differentiated in expected ways by their patterns of vocational interests. Second, interest scores should be indicative of subsequent career program decisions. That is, one would expect to see a sizeable number of students progressing in career programs compatible with their pattern of interest scores. Third, evidence supporting the construct validity of the interest measures should be available. In addition to evidence implied by the considerations cited above, information on the interest dimensions assessed by a particular instrument is especially relevant. Are these dimensions the expected and desired dimensions? Are they in line with interest theory and other research? Are they the dimensions on which differences among occupations occur? These are just a few of the questions pertinent to the construct validity of an interest inventory. Evidence bearing on all three considerations is needed to justify the usefulness of an interest inventory with career-oriented students.

A number of studies have already shown that measures of vocational interests differentiate students in various college educational programs (e.g., Baggley & Campbell, 1967; Berdie, 1955; Borgen, 1972; Stahmann, 1969), students in occupationally-oriented educational programs (e.g., Doerr & Ferguson, 1968; Passmore, 1968; Prediger, 1971; Pucel, Nelson, Asche, & Faurot, 1972; Stewart, 1966, 1968), and enlisted navy men in career training programs (Clark, 1961).

Whitney (1969) reviewed the evidence concerning the predictive validity of interest inventories, a topic associated with the second consideration above. Results from studies using 4-year college samples and various interest inventories generally indicated that anywhere from 40 to 75% of students could be classified into the correct educational program. Data from Project TALENT found similar percentages of correct classifications using a 17-scale interest inventory. Of course, the percentage of students correctly classified is a function of the number of groups involved, the base rates for these groups, and the particular definition of "correct" employed. Hence, it is difficult to compare results across studies.

Several recent studies also suggest that the domain of vocational interests can be described by a relatively few basic dimensions and that these dimensions represent a continuum of interests in a circular fashion (Holland, Whitney, Cole, & Richards, 1969; Roe, 1956; Roe & Klos, 1969). This structural organization provides a convenient way to summarize information obtained from interest inventories (Cole & Hanson, 1971) and applies to women in the same manner as it does to men (Cole, 1973). The usefulness of Holland's conceptual framework for career-oriented students has also been suggested (The American College Testing Program, 1972).

Studies using different interest inventories and different samples have provided enough evidence to indicate their potential usefulness with career-oriented students. The major objective of this study is to determine if an interest inventory measuring eight interest dimensions can (a) differentiate among students enrolled in various career-oriented educational programs and (b) accurately classify students into the educational program major in which they are progressing. A secondary objective is to examine whether the interest structure proposed by Holland et al. (1969) applies to career-oriented students. Evidence on this question will be relevant to the construct validity of both Holland's theory and the interest inventory.

## Method

### *Sample*

For purposes of this study 501 women and 629 men were selected from a larger sample of 1,743 women and 2,748 men who had completed the ACT Vocational Interest Profile (VIP), had completed the first semester (or quarter) of a 2-year school with a 2.0 (C) GPA or higher in coursework related to their educational program, and who had expressed general satisfaction with their program of study.[1] Sampling from the larger pool of students was based on two considerations. First, for ease and clarity of interpretation the number of different educational program groups was limited to eight for men and seven for women. The particular educational program groups were included because they characterized one of the interest scales of the ACT VIP. For example, the Accounting educational

[1]A more detailed description of the larger sample may be found in Chapter 5 of the *Handbook for the Career Planning Program*, 1972 edition, available from the authors upon written request.

program for men was selected to represent the Business Detail interest scale and the Nursing educational program for women was selected to represent the Health interest scale. Second, the educational program groups in the original sample varied considerably in size with the large groups having from four to five times as many students as the smaller groups. In discriminant analysis, the statistical procedure chosen to study program differentiation, unusually large groups affect the nature of the discrimination since variables which separate the large groups may receive considerably greater weight than variables that discriminate between smaller groups. Hence, the larger educational program groups were reduced in size by eliminating every "*n*th" student to provide more equal sample sizes. Table 1 shows the number of males and females in each educational program group and the number of different educational institutions represented in each program area.

*Instrument*

The VIP is a relatively new interest inventory consisting of eight scales, six of which correspond closely to the interest dimensions described by

**TABLE 1**

**Number of Students and Institutions Involved in Discriminant Analyses across Educational Programs**

| | Men | | Women | |
|---|---|---|---|---|
| **Educational Program Area** | No. of Students | No. of Instit. | No. of Students | No. of Instit. |
| Science (Transfer) | 112 | 51 | —— | —— |
| Data Processing | —— | —— | 80 | 32 |
| Nursing (Registered) | —— | —— | 76 | 22 |
| Other Health | 74 | 20 | —— | —— |
| Arts & Humanities (Transfer) | 49 | 16 | 69 | 17 |
| Social Science (Transfer) | 56 | 22 | 106 | 29 |
| Business & Marketing | 83 | 31 | 47 | 16 |
| Accounting | 76 | 28 | 87 | 27 |
| Machine Work | 95 | 20 | —— | —— |
| Other Trades | —— | —— | 36 | 11 |
| Electrical Engineering Tech. | 84 | 34 | —— | —— |

Holland (1966). Because the VIP is part of ACT's Career Planning Program developed for prospective community and technical college students, two additional scales were added to more specifically cover the health and technical career areas. Each scale consists of ten activities. Students indicate how much they would like doing each activity by using a five-point scale varying from "dislike very much" to "like very much." The eight scales and their hypothesized structural relationships to each other are presented in Figure 1.

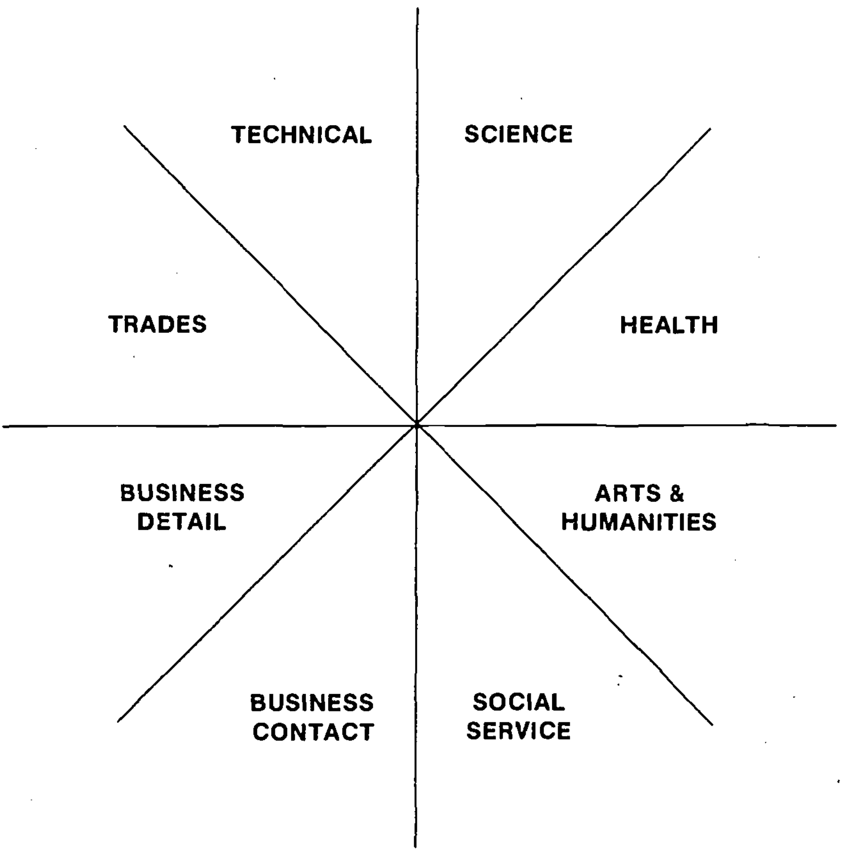


**Fig. 1.** Circular configuration showing hypothesized structural relationships among the eight VIP scales.

*Analyses*

Three types of analyses were performed for this study. First, multiple discriminant analysis was used to determine the nature and extent of specific educational program differences in terms of vocational interests. Overall statistical significance of multivariate profile differences between educational program groups was determined by examining Wilk's lambda, an index reflecting the ratio of within-group variation to total group variation. The nature of educational program differences was determined by examining the correlation between the VIP scales and the first three significant discriminant factors (functions) as well as the univariate *F* statistic obtained from a simple one-way analysis of variance across programs. In addition, a two-dimensional plot of educational program centroids was made. A centour ellipse including 50% of the cases for one group was estimated to illustrate the degree of group dispersion on the first two factors.

In the second type of analysis the appropriateness of guidance suggestions based on VIP scores was investigated through a check on the accuracy of the scores in classifying individuals into their respective educational programs. Since centour scores (Rulon et al., 1967) derived from the VIP were to be used with counselees considering career education programs, individuals in the validation sample were assigned to the group for which the highest centour was obtained. A "hit" was tabulated if the actual group membership and the group indicated by the highest centour were the same. However, a major guidance use of interest inventories is to suggest career alternatives. Hence, "near hits" were tabulated if the second or third highest centours were the same as the actual group membership.

The third type of analysis used spatial configuration (Cole & Cole, in press) to examine the relationships among the VIP scales for the male and female samples. Spatial configuration analysis fits a smaller space to the vector points corresponding to the correlations among scales in p-space (six space, in this case). This reduction in the number of dimensions needed to summarize the relationships between variables usually leads to a better understanding of the complex structure of the variables in a correlation matrix. Previous studies (Cole et al., 1971; Cole & Hanson, 1971; Cole, 1973) have shown that a two-dimensional space accounts for a majority of the variation of the vector points in p-dimensional space. Thus, the complex interrelationships between many variables may be better understood by examining the distances between variables on the two-dimensional plane. Variables showing a high degree of relationship fall close together on the plane, and the variables with a low degree of relationship fall farther apart. This analysis was used to determine if the VIP scales used with career-oriented students have the circular structure proposed by Holland et al. (1969).

## Results

*Discriminant Analysis Results*

Considerable educational program differentiation was found using the eight VIP scales. The Wilk's lambdas (.161 for men and .271 for women) and associated multivariate analyses of variance *F* values presented in the footnote in Table 2 indicate that the program differentiation for men and women is extremely unlikely to be the result of chance. Although a direct statistical comparison with other studies is not possible because of differences in the nature and number of groups, the degree of program differentiation found in this study is similar to previous findings. For example, Baggley and Campbell (1967), using six interest variables on a mixed sample of men and women from 18 educational major fields, obtained a Wilk's lambda of .24. Borgen (1972) obtained a Wilk's lambda of .23 when he used either 22 SVIB Occupational scales or 22 Basic Interest scales to differentiate National Merit Scholars enrolled in 16 different educational majors.

A comparison of the univariate *F* values listed in Table 2 provides an indication of which VIP scales are most effective in differentiating the educational programs. For men, the top four scales were Technical, Health, Business Detail, and Science. For women, they were Health, Business Detail, Social Service, and Technical, with Science and Arts not far behind. Thus, there is substantial similarity in the most effective scales for men and women with Social Service for women replacing Science for men.

Correlations (factor loadings) of the VIP scales with the first three discriminant factors for each sex are also shown in Table 2. These correlations reflect the nature of the discriminant factors in terms of the individual interest scales. For example, the first discriminant factor for men can be defined in terms of a technical/science-business continuum; the second factor in terms of a business-health continuum; and the third function in terms of a trades-health and social service dimension. Since the educational-program groups were not the same for men and women the nature of the first three discriminant factors for women was quite different. The first discriminant factor for women can be described in terms of a health-business detail continuum. The second function represents a distinction between artistic interests on one hand and a combination of health and business detail types of interests on the other. The third factor representing a relatively weak dimension, is not easily interpretable.

The contribution of the first three factors to overall group discrimination for each sex is shown in the last three rows of Table 2. Bartlett chi-squares associated with each factor for each sex indicate that the group discrimination on the basis of that discriminant factor is extremely unlikely to be the result of chance. According to the "percent of trace" values, the

**TABLE 2**

**Contribution of VIP Scales to Differentiation of Educational Programs**

| | Men (N=629) | | | | Women (N=501) | | | |
|---|---|---|---|---|---|---|---|---|
| | Correlation with First 3 Discriminant Factors | | | | Correlation with First 3 Discriminant Factors | | | |
| **VIP Scales** | *1* | 2 | 3 | Univariate F[a] | *1* | 2 | 3 | Univariate F[a] |
| Science | -.56 | .23 | .30 | 27.5 | .30 | .31 | .33 | 9.0 |
| Health | .19 | .62 | .52 | 30.5 | .66 | .50 | -.08 | 32.3 |
| Arts | .18 | .15 | .33 | 10.2 | .26 | -.41 | .32 | 9.1 |
| Social Service | .33 | .16 | .48 | 14.6 | .30 | -.07 | .33 | 10.9 |
| Business Contact | .52 | -.37 | .33 | 26.5 | -.33 | -.18 | -.29 | 7.3 |
| Business Detail | .47 | -.48 | .27 | 28.6 | -.61 | .48 | .04 | 27.3 |
| Trades | -.40 | .09 | -.58 | 21.8 | .04 | -.05 | .36 | 3.6 |
| Technical | -.80 | -.15 | .25 | 49.8 | -.20 | .27 | .52 | 9.7 |
| Bartlett's $X^2$ | 426 | 288 | 207 | | 314 | 160 | 80 | |
| Degrees of freedom | 14 | 12 | 10 | | 13 | 11 | 9 | |
| Percent of trace | 42% | 25% | 17% | | 54% | 23% | 11% | |

**Note.**—Wilk's lambda = .161 for men and .271 for women. The associated F-values are 23.9 (d.f. = 56 & 3,311) and 15.2 (d.f. = 48 & 2,400) for men and women respectively.

[a]For men an $F > 2.0$ is needed to exceed the 99th percentile point of the appropriate F distribution (d.f. = 7 & 621). For women an $F > 2.2$ (d.f. = 6 & 894) is needed.

first three factors accounted for 84% and 88% of the discriminating power of the VIP scales for men and women respectively. Each of the remaining discriminant factors accounted for 8% or less of the trace. As can be seen from the table, most of the discriminating power of the VIP is associated with the first two factors.

The program centroid (mean discriminant score) plots shown in Figures 2 and 3 for men and women provide a convenient way of summarizing program differentiation. Although the educational program areas are represented as single points (centroids) in Figures 2 and 3, considerable variation among members of a given program exists. An ellipse or scattergram which encompasses approximately 50% of the cases for one of the programs is presented to indicate the degree of group dispersion.

The VIP scales that correlate at least .40 with each discriminant factor are shown as anchors in Figures 2 and 3. Students enrolled in programs located near one end tend to score high on these interest scales and tend to score low on the scales at the opposite end. Thus, on Factor 1 in Figure 2, males enrolled in Electrical Engineering Technology are located near the anchor characterized by the Technical, Science, and Trades interest scales while males enrolled in Accounting and Business-Marketing are located toward the opposite anchor characterized by the Business Contact and Business Detail interest scales.

The second discriminant factor for males provides maximum differentiation of health-related programs and business-related programs (primarily Accounting and Business-Marketing). As seen in Figure 3, the first discriminant factor for women is very similar in nature to the second factor for males. In general, program differentiation is in accordance with expectations, given the types of interests that are assessed.[2]

*Centour Hit-Rate Analysis*

As already noted, centour scores were used in determining the accuracy of the interest scales in classifying individuals into the educational programs in which they were progressing. Although the results in this analysis appear in quite a different form, they actually represent just another way of looking at program differentiation.

Centour scores based on the first two discriminant factors were calculated for every educational program for each individual. The centour score reflects the similarity of the individual's profile of interests to a particular

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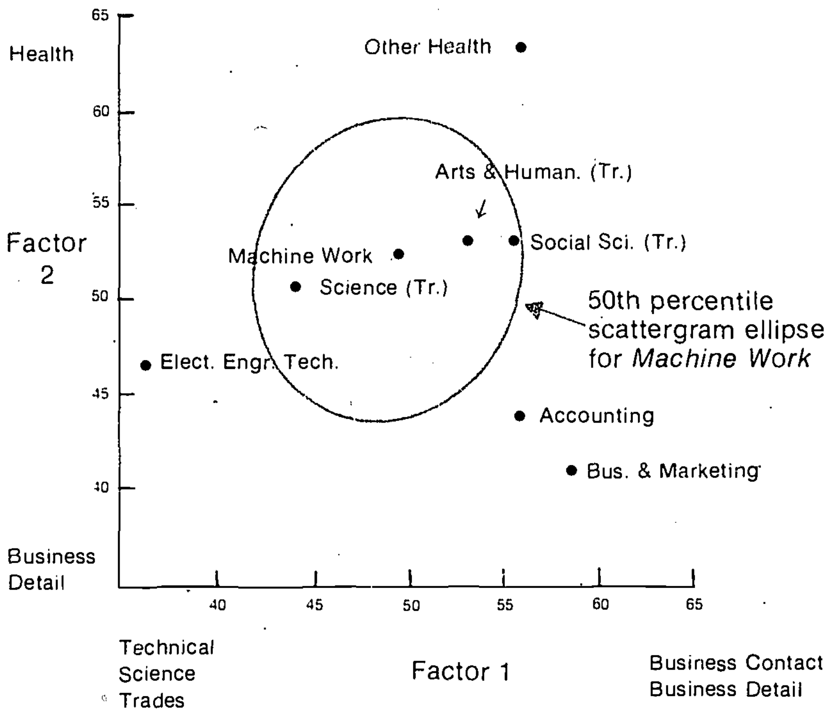
[2]The authors recognize the need to cross-validate and preliminary results using the same variables on different samples suggest very little shrinkage.




**Note.**—Discriminant factor score scales (Mean=50, S.D.=10) are based on all students included in the analysis. All measures correlating with the discriminant functions at .40 or higher are shown as function anchors in rank order according to level of correlation.

**Fig. 2.** Group centroids for eight male educational programs.

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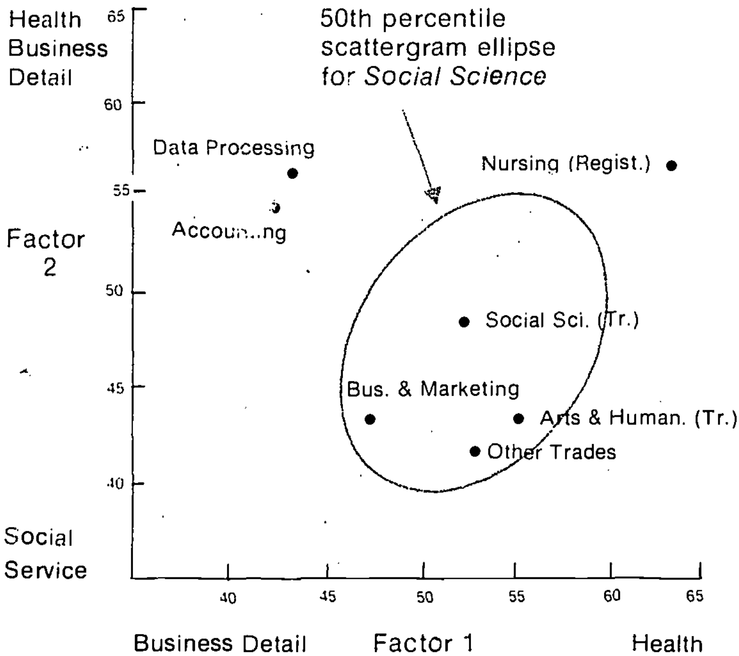
group. More specifically, the centour score directly reflects the percentage of individuals of a given group who fall farther away from the group's centroid (mean profile) than the individual. The higher an individual's centour score for a given group the more similar he is to that group. Thus, an individual could be classified into a particular group if this centour for that group was higher than for any other group.

However, in guidance uses of interest inventories, the purpose is not to predict what the counselee will do. Rather, it is to suggest appropriate




**Note.**—Discriminant factor score scales (Mean=50, S.D.=10) are based on all students included in the analysis. All measures correlating with the discriminant functions at .40 or higher are shown as function anchors in rank order according to level of correlation.

**Fig. 3.** Group centroids for seven female educational programs.

alternatives. These would consist of all programs with relatively high centours. For this reason, the results presented below include "hit rates" for the second and third highest centours in addition to the highest centour.

Table 3 presents the results for the eight male educational programs. Thirty-three percent of the men enrolled in the Science (Transfer) program obtained their highest centour for that group. Thirty-eight percent received their highest centour score in a different program but their second highest score was in the Science (Transfer) program. A total of 73.2% of the

### TABLE 3

**Percentages of Males within Each Educational Program Who Received Their Highest, Second Highest, or Third Highest Centour Scores for the Program in Which They Were Enrolled**

| | Actual Group Membership | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Centour Rank** | Science (Trans.) | Other Health | Arts & Humanities | Social Science (Trans.) | Business & Marketing | Accounting | Machine Work | Electrical Engr. Technology |
| Highest | 33.0 | 60.8 | 10.2 | 33.9 | 25.3 | 64.5 | 21.1 | 70.2 |
| 2nd Highest | 38.0 | 9.5 | 30.6 | 23.2 | 34.9 | 9.2 | 10.5 | 13.1 |
| 3rd Highest | 1.8 | 8.1 | 26.5 | 33.9 | 10.8 | 2.6 | 31.6 | 3.6 |
| Cumulative percentages for three highest centours | 82.8 | 78.4 | 67.3 | 90.0 | 71.0 | 76.3 | 63.2 | 86.9 |
| Sample size | 112 | 74 | 49 | 56 | 83 | 76 | 95 | 84 |

students in the Science (Transfer) program obtained either their first, second, or third highest centour score in the program. Comparisons for the other programs can be made in a similar fashion.

The percentage of males in each of the programs who obtained their highest centour score for the program in which they were enrolled varies considerably from program to program. Over 70% of the Electrical Engineering Technology males were correctly classified but only 10.2% of the Arts and Humanities males were correctly classified when just the highest centour was used. Considerable accuracy of classification is suggested by the cumulative percentage of hits and near hits. Over 91% of the Social Science (Transfer) group were correctly classified while even the poorest classification resulted in over 60% of the students in the Machine Work program receiving either their highest, second highest, or third highest centour for that program. The average cumulative percentage of hits or near hits across the eight male educational programs was 75%. This represents a considerable improvement over a chance level of classification (37.5%—3 chances in 8).

Similar comparisons for the seven female educational programs presented in Table 4 can be made. The percentage of hits ranged from 75% for the Registered Nurse program to about 14% for the Arts and Humanities program when just the highest centour score was used. The cumulative percentage of hits and near hits ranges from a low of 65.6% for the Social Science (Transfer) program to a high of 85% for the Data Processing program. Across all seven groups the average cumulative percentage of hits and near hits was 77% and represents a substantial improvement over a 43% (3 of 7) chance level of correct classification.

These results indicate that the six scales of the VIP successfully discriminate among students enrolled in career-oriented educational programs. That is, students progressing in these various educational programs have substantially different interest profiles. In addition, an individual's interest profile allows classification into the actual program of enrollment or a closely related program with a relatively high degree of accuracy.

*Spatial Configuration Analysis*

A first consideration in the spatial configuration analysis is the degree to which the relationships among the VIP scales in p-dimensional space may be represented on a two-dimensional plane. The percentage of the trace given by the first two dimensions is a measure of the goodness of fit of the planar surface to the points representing the scales in 6-space. Substantial portions of variance were accounted for by the two-dimensional plane for men (63%) and women (56%). Similar percentages of trace were found in

**TABLE 4**

**Percentages of Females within Each Educational Program Who Received Their Highest, Second Highest, or Third Highest Centour Scores for the Program in Which They Were Enrolled**

| | Actual Group Membership | | | | | | |
|---|---|---|---|---|---|---|---|
| **Centour Rank** | Computer Processing | Nursing (Regist.) | Arts & Humanities | Social Science (Transfer) | Business & Marketing | Accounting | Other Trades |
| Highest | 40.0 | 75.0 | 14.5 | 26.4 | 44.7 | 34.5 | 19.4 |
| 2nd Highest | 36.2 | 5.3 | 37.7 | 14.2 | 8.5 | 43.7 | 41.7 |
| 3rd Highest | 8.7 | 1.3 | 30.4 | 16.0 | 25.5 | 4.6 | 22.2 |
| Cumulative percentages for three highest centours | 84.9 | 81.6 | 82.6 | 56.6 | 78.7 | 82.8 | 83.3 |
| Sample size | 80 | 76 | 69 | 106 | 47 | 87 | 36 |

previous studies (Cole & Hanson, 1971; Cole, 1973). The two dimensions found here appear to represent a meaningful proportion of the variation of the scale points in p-space.

A second consideration is the configural plot of the VIP scale points of a two-dimensional plane. Figure 4 gives the spatial configuration of the VIP scales for men. The Health, Artistic, and Social Service scales fall close together on the plane indicating a high degree of relationship. Evidently, males view items comprising these scales as somewhat similar and do not make fine distinctions between them. All scales fall in the hypothesized circular order. It is interesting to note that the basic interest dimensions on which women typically obtain higher mean scores (e.g., Health, Arts, Social Service) appear more closely related for men. That is, they fall more closely together on the plane than do the scales for which men typically obtain high scores (e.g., Science, Technical, and Trades).

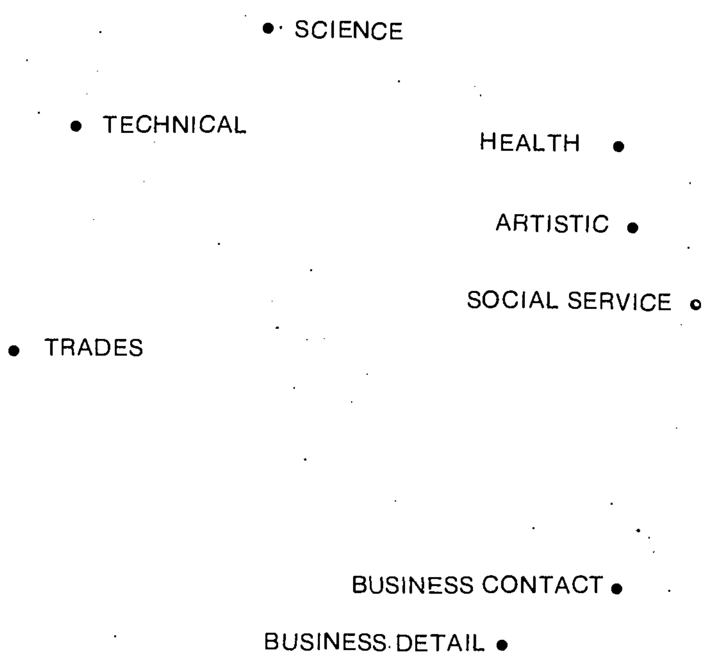



**Fig. 4.** Spatial configuration of eight VIP scales for 629 men.

Figure 5 presents the spatial configuration plot of the VIP scales for females.

Again, the eight interest scales generally conform to the hypothesized circular configuration. However, the Trades and Technical scales are highly related and are reversed in order. Evidently, the similarity of the items comprising these two scales when viewed from a female perspective do not result in fine discriminations being made and probably represent a single interest dimension for women.

For both the male and female samples the eight scales of the VIP generally fall in the hypothesized circular order which supports the usefulness of the Holland conceptual framework with career-oriented students.

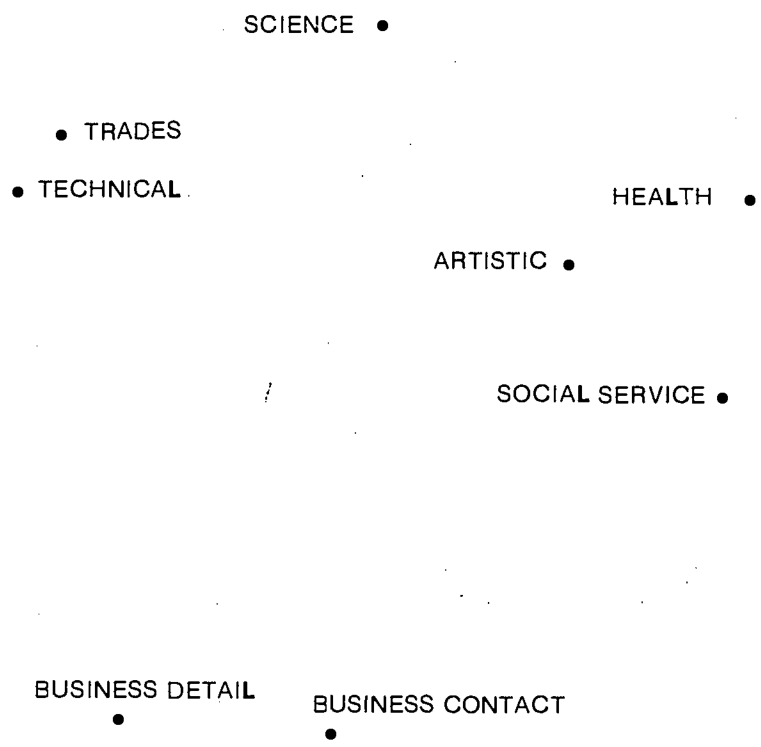



**Fig. 5.** Spatial configuration of eight VIP scales for 501 women.

## Discussion and Summary

The purpose of this study was to examine the vocational interests of students in career-oriented educational programs. Particular attention was given to whether students in various career-oriented programs could be differentiated in expected ways by measures developed to cover basic interest dimensions; whether these measures were indicative of subsequent career program decisions; and whether the measures were structured in the same way for career-oriented students as theory predicted and research confirmed for other groups.

The results indicate that educational program differentiation on the basis of a relatively few interest scales was particularly effective. In addition, the manner in which the various programs differed had considerable intuitive appeal. For example, the first discriminant factor which separated males in Electronics Engineering Technology from males in Accounting programs was a weighted composite of the Technical, Science, Business Contact, and Business Detail interest scales. Thus, the Electronics Engineering Technology males obtained high scores on the Technical and Science scales and low scores on the Business Contact and Business Detail scales. The Accounting majors had the reverse pattern. The group centroid plots illustrate how other educational programs differ from each other in terms of the interest scales of the VIP.

The ability of the scales of the VIP to accurately classify individuals into the educational program groups in which they were progressing was also examined. The results in terms of "hit rates" varied from moderate (60%) to good (90%). A cursory examination of the data indicated that students who did not obtain their highest centour score for the program in which they were enrolled often obtained their highest score in a closely related program.

Yet another finding is that the structure of the interest dimensions measured by the eight VIP scales closely corresponds to the hypothesized circular structure proposed by Holland. Since all of the occupations in the DOT have been classified according to Holland interest types (Viernstein, 1972), the practical implication of this finding is that students interested in career-oriented educational programs now have a way of relating their career interests to the entire world of work.

In summary, the findings of this study suggest that a relatively few interest scales appropriately differentiate students progressing in different career-oriented educational programs and that the hypothesized Holland interest structure is supported by the interest scores of a comprehensive sample of career-oriented students.

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# RELATING HIGH SCHOOL INTERESTS TO OCCUPATIONS FIVE YEARS AFTER HIGH SCHOOL

*John D. Roth, Gary R. Hanson, and Nancy S. Cole*

Relationships among the 17 scales of the Project TALENT Interest Inventory were considered for 11th and 12th grade students who later participated in a Project TALENT 5-year follow-up study. Two-dimensional spatial configurations were identified which ordered the scales in a highly similar manner for males and females at both grade levels. The configuration corresponded well with the organization of interest dimensions suggested by earlier studies involving other interest inventories and age-group samples. However, earlier studies frequently involved the concurrent assessment of interests and occupational status or plan. In this study, interest scores obtained in high school were grouped to reflect students' occupational status or plans 5 years after high school. These analyses suggested important similarities between the underlying dimensions of high school interests and dimensions which differentiate members of occupational groups 5 years later. Sex differences in the occupational choice patterns were identified and a potential method for applying the findings of the study within the student career exploration process was suggested.

The authors wish to express their appreciation to Dale J. Prediger for helpful suggestions resulting from his review of the manuscript.

The interrelationships of major dimensions of vocational interest as summarized in a circular configuration have been examined in a series of recent articles (Holland, Whitney, Cole, & Richards, 1969; Cole, Whitney, & Holland, 1971; Cole & Hanson, 1971; Edwards & Whitney, 1971; and Cole, 1972). The dominant configuration which has been consistently identified closely follows the circular ordering of interest dimensions first proposed by Roe (1956). Considering the six major interest areas identified by Holland (1966). the circular organization of interests proceeds from Realistic (R) to Intellectual (now referred to as Investigative) (I), Artistic (A), Social (S), Enterprising (E), Conventional (C), and back to Realistic, with adjacent dimensions suggesting greater psychological relatedness.

An early description of the circular configuration of interest dimensions was provided by Cole et al. (1971) for male 2- and 4-year college students who had completed Holland's Vocational Preference Inventory. Similar interest configurations were noted by Cole and Hanson (1971) for 2-year post-high school educational program males who had completed the ACT Career Planning Program 12-13 Vocational Preference Inventory and for samples of employed males who had completed the Strong Vocational Interest Blank and the Kuder Occupational Interest Survey. In addition, Cole (1972) has noted the appearance of similar circular configurations of interest dimensions for females tested with the same instruments. The existence of such a basic configuration of interest dimensions and the relationships of various occupational groups to that configuration for both males and females is encouraging and suggests the potential value of this type of interest dimension organization for use with individuals in various stages of career exploration.

However, the research on the circular configuration of interest dimensions has been limited to concurrent assessments of interests and occupational aspirations or affiliations. To fully evaluate the value and usefulness of the configuration as a tool for guiding career exploration oriented toward future decisions, a link between interest scores for students in high school and later employment is needed. Such an investigation would provide information relevant to several questions, such as: How consistent is the configural mapping of interest dimensions when one considers several populations measured with the same instrument? Are there sex differences in the mapping of interest dimensions? Are occupations organized on the configural map with sufficient face validity to suggest generalizations about other related occupations not included in the analyses? Does the configuration of interests as measured in high school "hold up" in terms of later job choices made by students?

The purpose of this study is to explore the relationships between measured interests of high school students and the occupations which these students held or were preparing for 5 years later. By applying the method of configural analysis (Cole & Cole, in press) to the study of student interests and subsequent occupation, the usefulness of the circular configuration of interest dimensions for the purposes of guiding career exploration can be investigated. Ideally, the relative position of specific occupational groups plotted on the basis of interest measure scores can be shown to be consistently located in close proximity to the major interest dimension hypothesized as dominant for workers in the group. To the extent that this is true, it may be appropriate for students to direct their exploration activities toward occupations located in the area of the circular configuration suggested by the measured interests of the students.

## Data

The variables considered in this study include interest inventory scores for 11th and 12th grade students and the career status or plans of the same students when they had been out of high school 5 years. Analyses in this study are based on Project TALENT data presented by Flanagan, Shaycoft, Richards, and Claudy (1971b).

The Project TALENT Interest Inventory was developed as a survey of the interests of high school youth, specifically for the purpose of investigating the relationships of interests to educational and vocational choices. The 20-minute interest inventory consists of 205 items, including 122 occupational titles and 83 activities, with items allocated a priori to form 17 scales. Instructions direct the student to respond in terms of how well he or she would like or dislike the work or activity, using a 5-point rating scale. The interest inventory is part of the larger Project TALENT battery of tests administered to over 400,000 students in grades 9 through 12 in a 1960 national probability sample of high schools. A total of 99,259 juniors and 87,130 seniors participated in the 1960 testing.

Approximately 5 years after each class graduated from high school, a follow-up questionnaire was mailed to each of the original participants. A series of items in the follow-up questionnaire were designed to identify the occupational plan of each respondent. By screening these questions, the occupational group membership for each student was carefully purified by Project TALENT investigators "to include only those respondents who reported specific career plans and who were also making reasonable progress for obtaining these plans. Only those respondents who were actually in a job or who were in a position in a general type of training program which could lead to this job were included [Flanagan et al., 1971a, p. 6-2]."

Analyses were conducted for four separate samples, representing grade by sex partitioning of the grade 11 and grade 12 subjects who responded to the follow-up questionnaire. For each of the four samples, the specific data analyzed included the sample's means, standard deviations, and intercorrelation matrix for the 17 Project TALENT interest scales, along with the 17 mean interest scores for each of the purified occupational groups in the sample as presented by Flanagan et al. (1971b). Of the students tested in 1960, data for 14,570 junior males and 15,423 junior females along with 14,123 senior males and 14,703 senior females were included in this study.

Grade 11 males and females were considered separately to investigate the similarities and differences of the interest dimensions maps between the sexes, with resulting implications for the use of such maps with students in career exploration. Grade 12 males and females were also considered separately as replication studies to investigate the consistency and thus the generalizability of the configural ordering of interest dimensions as represented in two independent samples for each sex.

### The Analysis of Spatial Configuration

An analysis of spatial configuration which uses the method of principal components to examine relationships among variables is described by Cole and Cole (in press). Using the correlation matrix as a source of information about the relationships among variables, the analysis of spatial configuration fits a smaller space to the vector points which represent the principal component loadings of variables, or in this case, the scales of an interest inventory. To the extent that the loadings lie predominately in a smaller space, the relationships among the variables in terms of their principal components loadings may be summarized by fewer dimensions than the original number of components. This reduction in the number of dimensions required to summarize the relationships among the variables is intended to lead to clarification of the underlying dimensions. In several applications of this method (Cole et al., 1971; and Cole & Hanson, 1971), major dimensions of interests have been represented as a two-dimensional plane, with the relationships among variables plotted on a two-dimensional map.

Three types of information resulting from an analysis of spatial configuration are relevant to a discussion of the possible use of resulting interest dimensions for career exploration. For this study, a first consideration is the degree to which the relationships among the scales of an interest inventory may be represented by a two-dimensional plane. In the spatial configuration analysis proposed by Cole and Cole (in press), first and second stage principal components analyses are performed to reduce the dimensionality of the original variable space so that relationships among the variables may be more easily understood. If the first two principal components of the second analysis account for a significant portion of the variation of the variable points about the component axes, then the two-space representation of the variables can be used. To the extent that the remaining roots are small, the original variable loadings deviate little from the two-dimensional space spanned by the first two vectors.

A second consideration is the arrangement of the scales under study within the two-dimensional plane, with the scale configuration directed by the projection of the factor loadings of interest scales onto the plane as outlined by Cole and Cole (in press). In the two-dimensional case, factor loadings of the original interest scales can be plotted and visually related to each other on a plane.

The final consideration is the arrangement of occupational groups within the two-dimensional plane, with locations for occupational groups determined by the interests of group members as assessed when they were in high school. This projection may also be studied in conjunction with vectors drawn to represent the factor loadings of the original interest scales, with the purpose of identifying relationships between the placement of occupational groups and the vectors representing scales on the interest inventory.

## Results

### *Goodness of Fit of the Planes*

In the second stage analysis, the percentage of the trace given by the first two dimensions is a measure of the goodness of fit of the planar surface to the points representing scale loadings on components from the first stage analysis. Table I gives the results for the fit of the plane for each of the four groups of subjects considered. A percentage of the trace may be interpreted as the proportion of variance of the scale loading points accounted for by the selected number of dimensions, in this case two dimensions.

**TABLE 1**

**Goodness of Fit of the Planes**

| | *Percentage trace accounted for by the plane* | | |
|---|---|---|---|
| *Sample* | Dimension 1 | Dimension 2 | Total |
| 11th Grade Males | 27.0 | 16.3 | 43.3 |
| 11th Grade Females | 23.6 | 17.0 | 40.6 |
| 12th Grade Males | 26.8 | 17.1 | 43.9 |
| 12th Grade Females | 24.6 | 17.3 | 41.9 |

As noted in Table 1, the two-dimensional surface representing the 17 scales of the Project TALENT Interest Inventory accounted for slightly over 40% of the variance in the scale points for each of the four samples. These percentages are near the lower end of the range of percentages of the trace accounted for by two dimensions in six sets of interest scales analyzed by Cole and Hanson (1971). Cole and Hanson reported percentage of trace values for two dimensions ranging from 37.8% to 63.7% and suggested that percentages near 50% or higher are substantial for interest instruments designed to measure many factors in the complex domain of individual interests.

The consistency of the percentage of trace accounted for by the two-dimensional surface in these four different samples suggests that the complexity of the dimensions for grades 11 and 12, males and females considered separately, is quite similar.

### *Plotting the Interest Scales in a Two-Dimensional Plane*

Projection of the interest scales onto a two-dimensional plane may contribute to the understanding of the relationships among the scales. In an earlier plotting of the interrelationships of Holland's six interest scales for a sample of males in 2- and 4-year college programs, Cole et al. (1971) presented the configuration which appears in Figure 1. The Intellectual (Investigative) interest dimension was most typical of male college students planning to enter occupations such as physics, biology, and natural science education, while the Realistic interest dimension included males preparing for mechanical engineering, civil engineering, farming, and construction occupations. Occupations typifying the Conventional interest dimension included data processing, business management, and accounting, with marketing and public relations advertising being closer to the Enterprising dimension. The interests of males in theology, clinical psychology, art, and music centered in the Artistic area with occupations such as history, teaching, counseling and guidance, and speech and drama being closer to the Social interest dimension. The circular ordering of interests in this configuration is consistent with the expectation that students preparing for occupations in adjacent clusters have more interests in common than do students considering occupations in clusters directly across the configuration.

For each of the four samples (grade 11 males, grade 11 females, grade 12 males, grade 12 females) of the present study, the interest scale points were projected onto the best fitting planar surface. Each of the planar configurations has been graphically rotated to a common orientation to facilitate comparisons of the relationships within these samples and with the Cole et al. (1971) configuration.

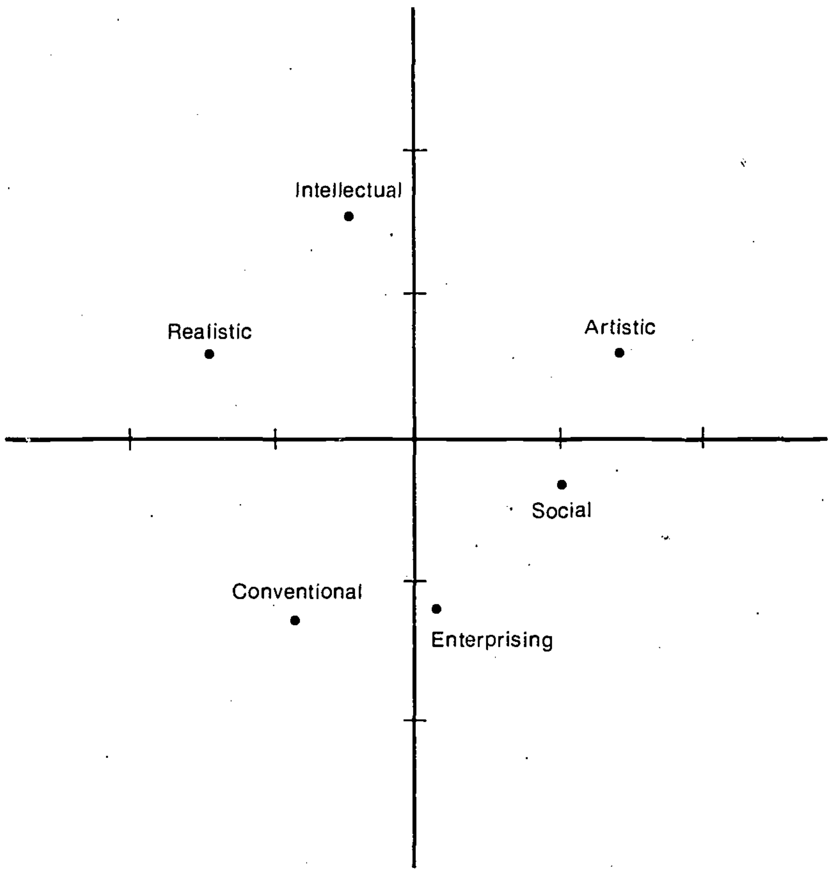



**Fig. 1.** Spatial configuration of Holland's six Vocational Preference Inventory scales for males entering 2-year and 4-year colleges.

The configuration of the 17 Project TALENT interest scales for 11th grade males and 12th grade males is given in Figure 2. Although separate analyses were conducted for each sample, the results have been plotted on the same set of axes to aid in comparing the results. The highly similar scale configurations for the two large samples suggest construct validity for the configuration as representing basic relationships among the interest scales for males. In general, the distances between like named scales for the two samples are less than the distances between two different scales within the same sample. In a companion figure available from the authors, a similar scale configuration based on 11th grade and 12th grade females is also apparent.

Comparison of the relative locations of the Project TALENT interest scale titles in Figure 2 with the concept expressed by each of the interest dimensions identified by Holland confirms the expected similarities of the two configurations. For example, by considering scales 1 and 2 of the Project TALENT Interest Inventory as approximating the Intellectual (Investigative) dimension suggested by Holland, the ordering and relative

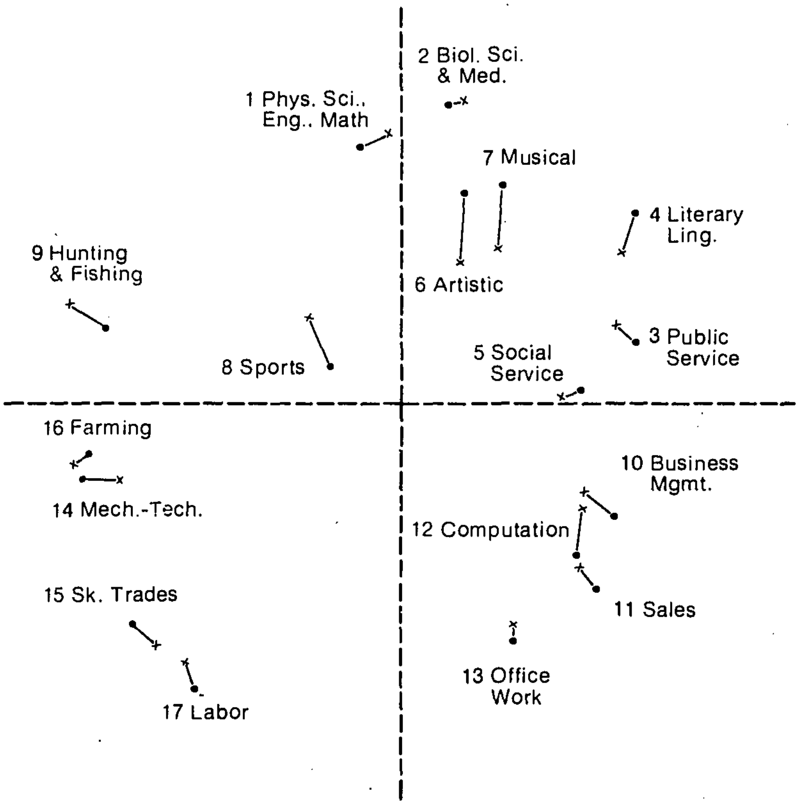



**Fig. 2.** Spatial configuration of Project TALENT Interest Inventory scales for 11th grade (x) and 12th grade (•) males responding to a follow-up questionnaire 5 years after high school.

placement of interest dimensions within each configuration is very similar. However, within the Project TALENT data, scales corresponding to Holland's description of the Realistic dimension appear to dominate the lower left of the interest configuration. This domination may be due to the inclusion of new variance associated with the relatively large number of scales related to the Realistic dimension. For example, two of these scales, Hunting and Fishing and Sports, are not strictly occupational interest scales but interest in these areas would be expected to be characteristic of Holland's Realistic type. If these scales introduce variance not included in Holland's measures, they would be expected to require "room" on the configuration, thus influencing the relative placement of the remaining interest scales. By identifying the Labor, Skilled Trades, Mechanical-Technical, Farming, Hunting and Fishing, and Sports scales as representing the Realistic category, over one-third of the 17 Project TALENT scales relate to this single category. With the exception of three scales (Artistic, Musical, Literary-Linguistic) related to Holland's Artistic dimension, each of the remaining Holland categories is represented by just two scales. However, this relatively uneven representation of Holland's dimensions still results in a configuration of scales having an ordering of interest dimensions similar to that suggested by Cole et al. (1971) with one area of the configural map dominated by scales corresponding to Holland's Realistic dimension.

While the configural mapping of these 17 interest scales in two-dimensional space is consistent within sex across the two grade samples, more generalized application of these results in career guidance activities requires that the question of sex differences and similarities also be examined. Figure 3 presents the configuration of the 17 interest scales for males and females of the 11th grade, with the two configurations again reoriented after inspection to facilitate comparisons of the circular orderings of the scales within each sex sample.

The dominating characteristic of the two-dimensional plotting of interests represented in Figure 3 is the highly similar interest configuration for males and females. Again, with few exceptions, the distances between like named scales for males and females are less than the distances between two different scales. Of primary importance for career guidance use of these interest dimension configurations is the highly similar configural ordering of scales within the male and female samples, suggesting that a single configuration may accurately describe relationships among interest dimensions for both males and females. For example, considering the upper right quadrant of the two-dimensional plotting of interest dimensions, the scale points for 11th grade females demonstrate the following clockwise ordering of scales: Artistic, Musical, Literary-Linguistic, Public Service, and Social Service. Precisely the same ordering of these scale points exists for 11th grade males. Among the remaining scale points, only the Biological

Science and Medicine and the Computation scales show minor exceptions to the statement that the configural ordering of interest scales in two-dimensional space for females and males of these samples is identical.

While the ordering of scales is highly similar for females and males, the spacing of the scales demonstrates one set of differences in the scale configurations for males and females which should be noted. In particular, the area of the spatial configuration in which the scales correspond most closely to Holland's Enterprising and Conventional dimensions suggests a possible difference between the two-dimensional interest mapping for females and males which may be significant for high school assessment of

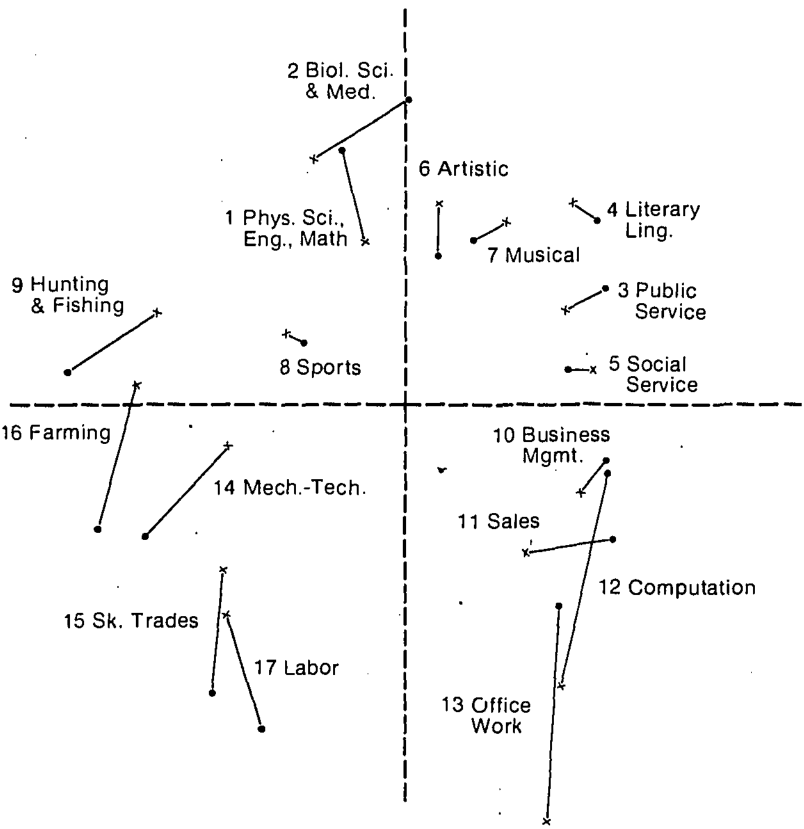



**Fig. 3.** Spatial configuration of Project TALENT Interest Inventory scales for 11th-grade females (x) and 11th grade males (•) responding to a follow-up questionnaire 5 years after high school.

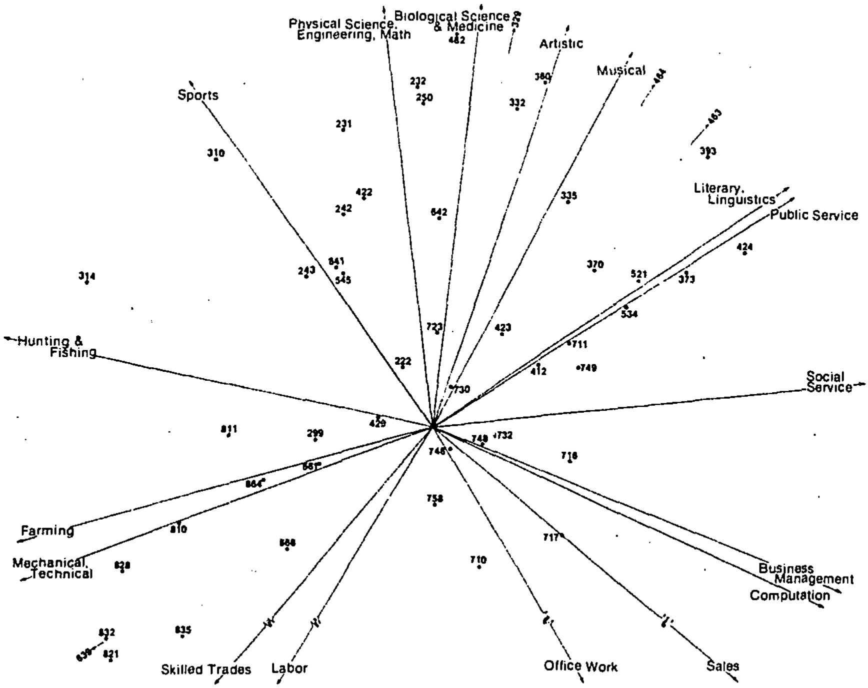
interests. As suggested by the placement of the four scales related to Holland's Enterprising and Conventional interest types (Business Management, Sales, Computation, and Office Work), scores on these scales did not covary as uniformly for females as they did for males. Males would appear to be showing less differentiation in their responses to these scales than females.

*Projecting Mean Interest Profiles of Occupational Groups onto the Two-Dimensional Interest Space*

The application of the configural mapping of interest dimensions as an aid in career exploration is predicated on the assumption that there is a useful and generally direct correspondence between measured interests and later occupational entry. One way to investigate the directness of these relationships is to develop the configuration of measured interests as obtained during high school and then project the mean interest profiles of specific occupational groups onto the same configuration. If a direct relationship between configurations of measured interests and occupational entry exists, occupational groups should fall closer to vectors representing logically related interest dimensions than to unrelated interest dimensions. Thus, one would intuitively expect the mean interest profile of chemists to fall near the Intellectual (Investigative) interest dimension vector on the configuration.

In Figure 4, vectors are used to represent the 17 Project TALENT Interest Inventory scales for grade 11 males, with points used to represent the projection of occupational mean interest profiles for 50 selected occupations onto the same two-dimensional plane. To be included in Figure 4, each male occupational group had to have 40 or more members. In general, occupational groups tend to cluster around the appropriate interest scale vectors. For example, Machinist, Electrician, Plumber, and Pipefitter tend to fall nearer the Mechanical interest vector. Physicist, Chemist, and various groups of engineers tend to fall nearer the Physical Science, Engineering, and Mathematics interest vector.

Consideration of standard scores on the interest scales for specific occupational groups assists in providing greater understanding of the interest patterns represented by points on various areas of the configuration. When an occupational group has a pronounced peak (a high mean) on a particular scale, that group will generally be located farther from the center of the two-dimensional plot than an occupational group with a relatively flat profile. For example, the College-University English Teachers fall to the extreme right hand side of the interest space, reflecting a high mean score on the Literary-Linguistics interest scale. Likewise, the Farming occupational group has a high mean on the Farming interest scale and falls




222 Computer Programmer (173)
231 Chemist (93)
232 Physicist (53)
242 Elec. Engineer (234)
243 Mech. Engineer (139)
250 Architect (64)
299 Phys. Sci., Lab Tech. (100)
310 Biologist, Zoologist (48)
314 Wldlf./Forest Spec. (43)
329 MD (186)
332 Dentist (92)
335 Pharmacist (89)
360 Psychologist (94)
370 Social Worker (65)
373 Voc./Ed. Guidance (42)
393 Lawyer (342)
412 Teacher-Elem. (59)
422 Teacher-HS Science (68)
423 Teacher-HS Soc. St. (85)
424 Teacher-English (68)
429 Teacher-Phys. Ed. (57)
462 Coll. Tchr.-Science (48)
463 Coll. Tchr.-Soc. Sci. (81)
464 Coll. Tchr.-English (44)
521 Clergyman (177)
534 Journalist/Reporter (43)
545 Comm. Artist (54)
639 Farmer (other) (204)
642 Military-Officer (111)
661 Police (public) (188)
666 Fireman (48)
710 Banking & Finance, I (66)
711 Banking & Finance, II (114)
716 CPA (167)
717 Acctant. (Exc. CPA) (329)
723 Efficiency Expert (130)
730 Bus., Mgmt., Adm. (nec) (514)
732 Whsl./Ret. Mgmt./Mktg. (204)
746 Insurance Slsman. (69)
748 Other Slsman. (nec) (327)
749 Sales Mgr. (63)
758 Computer Operator (97)
810 Electrician (211)
811 Electric Tech. (258)
821 Auto Mechanic (112)
828 Machinist (276)
832 Carpenter (63)
835 Plumber, Pipefitter (81)
841 Pilot (164)
864 Draftsman (134)

**Fig. 4.** A spatial configuration of Project TALENT Interest Inventory scales (vectors) and selected occupational mean interest profiles (points) for grade 11 males based on interests measured in high school and occupational membership defined 5 years after high school (N in parentheses).

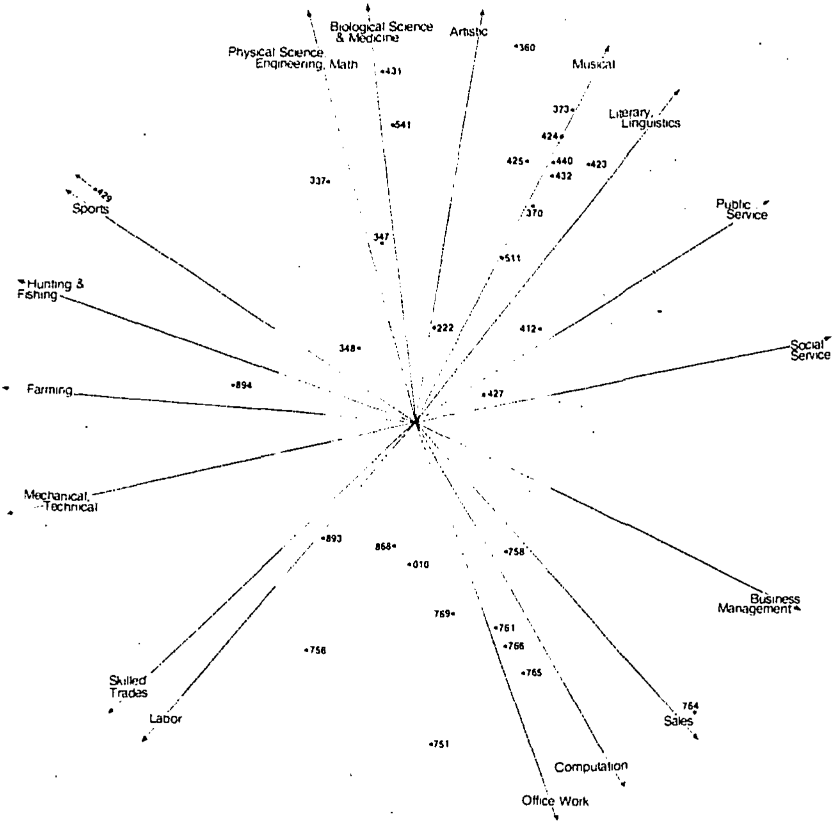
to the extreme left of the configuration. Occupational groups with relatively flat interest profiles tend to fall near the center.

Study of the spatial configuration presented for males in Figure 4 suggests that certain occupational groups consisted of individuals with pronounced interest peaks while in high school. For example, students who eventually entered the biological and physical sciences (e.g., Biologist, Zoologist, Physicist, etc.) tended to obtain high means on the Biological Science and Physical Science interest scales. Likewise, students who entered the Skilled Trades and Mechanical occupations (e.g., Electrician, Plumber, Carpenter, and Auto Mechanic, etc.) also obtained high means on related interest scales, in particular the Farming, Mechanical, and Skilled Trades scales. However, groups of males who entered business-related occupations were not characterized by well defined interests in the business area while in high school, as indicated by the number of such occupational groups falling near the center of the spatial configuration.

Figure 5 presents interest scale vectors and points representing occupations for females who entered or planned to enter a selected number of occupations.

Occupational groups were again required to consist of 40 or more members. Because 6,168 (40%) of the 11th grade females in the follow-up sample selected the category "Housewife" as representing their occupational status, only 30 occupational groups were considered to be large enough to be included in Figure 5.

The 17 interest scale vectors in general follow the circular configuration noted earlier for males. However, consideration of the occupations represented by 40 or more subjects suggests that these female high school students for the most part entered two major categories of occupations. One cluster of occupations is office oriented and consists of Secretary, Clerk Typist. Bookkeeper, Keypunch Operator and Clerk. These occupational groups tend to cluster around the Computation and Office Work interest scale vectors. The other predominant cluster of occupations consists of various teaching occupations such as English, Music, Foreign Language, Social Studies, and Elementary Teachers, with a second component of this cluster consisting of Social Workers and Vocational-Educational Guidance Counselors. Interestingly, the occupations in this second cluster fall near the Artistic, Music, and Literary interest scales rather than the Social and Public Service scales. The Fine Arts and Art Teacher scale fall more in the direction of the Biological and Physical Science scales as do the Medical-Dental Technologist, Registered Nurse, and Medical-Dental Technician.




| | | | | | |
|---|---|---|---|---|---|
| 010 | Housewife (6168) | 424 | Teacher-English (132) | 756 | Keypunch Op. (69) |
| 222 | Computer Programmer (53) | 425 | Teacher-For. Lang. (46) | 758 | Computer Operator (57) |
| 337 | Reg. Nurse (591) | 427 | Teacher-HS Home Ec. (68) | 761 | Secretary (nec) (851) |
| 347 | Med./Dent. Technologist (93) | 429 | Teacher-Phys. Ed. (59) | 764 | Legal Secretary (45) |
| 348 | Med./Dent. Technician (138) | 431 | Teacher-Art (50) | 765 | Steno, Crt. Reporter (49) |
| 360 | Psychologist (47) | 432 | Teacher-Music (65) | 766 | Typist, Clerk Typist (68) |
| 370 | Social Worker (177) | 440 | Teacher-Handicapped (70) | 769 | Clerk (misc.) (99) |
| 373 | Voc./Ed. Guidance (40) | 511 | Librarian (77) | 868 | Clthng. & Fashn. Trades (41) |
| 412 | Teacher-Elem. (616) | 541 | Fine Arts (42) | 893 | Hairdresser (201) |
| 423 | Teacher-HS Soc. St. (54) | 751 | Bookkeeper (100) | 894 | Practical Nurse (168) |

**Fig. 5.** A spatial configuration of Project TALENT Interest Inventory scales (vectors) and selected occupational mean interest profiles (points for grade 11 females based on interests measured in high school and occupational membership defined 5 years after high school (N in parentheses).

Several occupational groups appear which are not a part of either of these two major clusters. For example, Physical Education Teachers and Practical Nurses fall near the Hunting, Sports, and Farming interest scales and the Hairdresser and Clothing and Fashion Trades fall near the Skilled Trades and Labor interest scales. The Computer Programmer group falls near the Social Service interest scale not because of particularly high interests in that area but because of a combination of the Scientific-type interests at one end of the configuration and the Computation and Office Work interests at the other end. This results in a position midway between the two and pulled in the direction of the Social Service area only because of tertiary interests in that area.

Although the structure of the interest dimensions for high school females follows the circular configuration rather closely, the occupational choices of women as represented by frequency counts once they enter the world of work appear to be concentrated in two clusters of occupations. Women tend to enter either office-related occupations or artistic and social service related areas. Several occupations are represented in other positions around the hypothesized circular configuration but the relatively few women entering many other areas disallows their plotting within these analyses.

## Summary

The purpose of this study was to examine the relationship between interest measures obtained in high school and occupational entry 5 years later in terms of the circular configuration of interests and occupations found in previous research. Several interesting findings emerged from this study. First, a circular configuration was identified which ordered the 17 Project TALENT interest scales in a highly similar manner for males and for females at both the 11th and 12th grades. The configuation closely resembles the organization of interest dimensions suggested by earlier studies based on different interest inventories and different age-group samples. The continuing emergence of this basic configuration of interest dimensions recommends it as an important conceptual framework for use in work involving the assessment and interpretation of interests. As suggested by Cole and Hanson (1971), the circular configuration for summarizing interest dimensions provides a useful framework for the comparison of results obtained from different interest inventories.

A second important finding supported by this study concerns the similarity of the underlying dimensions of interests, as measured during high school, and the dimensions that differentiate members of occupational groups in expected ways. Results of previous studies using measures of interests and occupational aspiration or occupational group membership have suggested that interests and occupations can be organized on the same dimensions, with certain heuristic appeal for counselors working with students in the process of career exploration. Locating the interests of an individual on a spatial configuration of occupations would allow the individual to identify a variety of occupations which occupied a similar position, suggesting groups of occupations the student may wish to consider in career exploration—given the assumption that interests and occupations could be organized according to a similar structure. While previous studies have suggested that interests and occupations may be organized within a similar configuration, these studies have typically involved concurrent assessment of interests and occupational aspiration or group membership. The present study, however, involved the assessment of interests of students while in high school, with the measures of occupational plan or group membership obtained 5 years after high school.

The results suggest that for men of the present sample, underlying dimensions of interests as identified in a configural analysis are related to the dimensions that differentiate occupational groups in the mechanical, scientific, artistic and social service areas. However, males who entered occupations in business related areas appeared to have relatively flat and undifferentiated interest profiles while in high school, suggesting a lack of clearly defined patterns of interests for these groups in high school.

For women yet a different result was found. While the underlying dimensions of interests were generally ordered in the expected circular configuration, the occupations these students eventually entered, as reflected in frequency of entry counts, suggested two main categories of a business cluster and an artistic and social service cluster. The fact that occupational groups representing different points on the continuum could not be found with sufficient numbers to include in this analysis suggests that other factors play an important role in determining which occupation a woman will enter. Thus, while the underlying dimensions of interests are highly similar for men and women in high school, suggesting that the same career options may be considered as possible entry occupations for males and females with similar interests, it appears that men may tend to more frequently enter occupations consistent with their interests while the choices of women may be more frequently influenced by other factors. Such factors may include well-recognized differences in role expectations, occupational stereotypes, and biases in employment practices.

An important extension and follow-up to this research would be to test the practical usefulness of relating a student's interest scores as represented by a point to the configuration of points representing the interests of occupational groups. Occupations closest to the student "point" could then provide suggestions of focus and direction for career exploration activities of the student. A test of the usefulness of such a model would require an evaluation of its success as a generator of career exploration behavior as well as its predictive validity as measured in follow-up studies.

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