Journal of Counseling Psychology
2004, Vol. 51, No. 3, 299–313


0022-0167/04/$12.00 DOI: 10.1037/0022-0167.51.3.299

# The Strong Ring: A Basic Interest Model of Occupational Structure

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A classification system and spatial map of occupations were developed using the Basic Interest Scale profiles of 198 occupational incumbent samples (31,010 women; 32,421 men) from the Strong Interest Inventory. Profile shape was found to be similar for incumbents of both genders, allowing for an analysis of combined-gender samples. Using hierarchical cluster analysis, the authors identified 9 general interest areas subdivided into 19 occupational clusters. Nonmetric multidimensional scaling was used to create a spatial representation, producing a 3-dimensional ringlike structure called the *Strong Ring*. Dimension labels were identified using property vector fitting of O*NET variables. These dimensions were (a) Persuasion Versus Problem Solving, (b) Structured Versus Dynamic, and (c) Social Service Versus Solitary Work. This new model provides an organizational and interpretive framework for professional, technical, managerial, and skilled occupations.

Of all widely used psychological tests, the Strong Interest Inventory, first published in 1927, has the longest history (Campbell, 1971). Research on the Strong Interest Inventory (herein called the *Strong*) has had a major impact on interest assessment and career counseling (Borgen, 1986). Of the many contributions, the introduction of the Occupational Scales (E. K. Strong, 1927), the development of Basic Interest Scales (BISs; Campbell, Borgen, Eastes, Johansson, & Peterson, 1968), and the use of Holland's (1959, 1997) theory to organize and interpret interest scales from the Strong (Campbell, 1974) have had a lasting effect on interest measurement (Hansen, 1984). The 1994 edition (Harmon, Hansen, Borgen, & Hammer, 1994) of the Strong is organized around Holland's theory, with BISs and Occupational Scales organized by Holland type. The purpose of the present study was to revisit the use of Holland's RIASEC classification system with the Strong scales and to develop an alternative classification system and spatial model using the BIS profiles of the Occupational Scales incumbent samples. We propose using basic interest profiles to develop a new occupational classification system because these measures allow for a more detailed and representative model of vocational interests than the Holland system.

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This research was partially funded by Consulting Psychologists Press and by research funding from the Department of Educational Psychology, University of Illinois at Urbana–Champaign. Previous versions of this article were presented at the 2001 American Educational Research Association conference in Seattle, WA, and at the 109th Annual Convention of the American Psychological Association, San Francisco, CA.

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## Basic Interests

The taxonomy of interest measurement can be divided into three levels, based on the specificity of the range of interests being represented (Hansen, 1984). In this taxonomy, basic interests represent an intermediate level of aggregation, lying between the specific occupation level and the general interest factor level (Day & Rounds, 1997). At the basic interest level, work activities are grouped to transcend specific situations or job descriptions, identifying shared properties of occupations such as context, setting, objects of interest, and processes. Basic interests span across specific job titles, making this level of the taxonomy more flexible than measures of interest in specific occupational titles, such as the Occupational Scales (E. K. Strong, 1927) of the Strong. In comparison with measures at the general factor level, such as the General Occupational Themes of the Strong (Harmon et al., 1994) based on Holland's (1959, 1997) RIASEC types, measures of basic interests make finer distinctions between areas of vocational interests, thus allowing for a model that may be more representative of interest structure (Rounds, 1995).

An additional advantage of the BIS (Campbell et al., 1968) concept is that it provides a level of flexibility that corresponds to changes in the labor market associated with a transition to a knowledge-based economy (Burton-Jones, 2001). Vocational interest researchers and theorists have begun to recognize the need for new interest models that reflect the reality of the changing economy. Traditional models were developed at a time when it was reasonable to plan a career on the basis of working for a single company; however, today's employers and employees seem less inclined to follow this model of career development than were prior generations, and vocational psychology must adjust accordingly (Hesketh & Bochner, 1994; Holland, 1996; Savickas, 1995). In this context, BISs reflect the nature of the changing vocational environment of the knowledge-based economy. Basic interests offer individuals the opportunity to maintain some sense of career coherence on the basis of a set of activities they value, instead of a consistent environment or job title (Day & Rounds, 1997). Despite this potential, basic interests have received less attention than the alternatives, and models of occupational structure based on basic interests have not been developed. The primary objective of the present study was to develop a model of occupational structure on the basis of basic interest profiles to provide a new interpretive framework linking interests and occupational opportunities. To outline the potential advantages of this approach, we begin with an examination of the limitations of Holland's (1959, 1997) interest types.

## The Holland Model

Holland (1959, 1997) has proposed a set of vocational personality types and working environments with six broad categories: Realistic (R), Investigative (I), Artistic (A), Social (S), Enterprising (E), and Conventional (C). These six categories, collectively referred to by the first-letter acronym RIASEC, can be used to classify an individual's interests and have influenced the development of interest measures (Campbell & Borgen, 1999), but can also be used to classify characteristics of an occupation. By matching an individual's most salient interests to occupational characteristics by Holland category, it is possible to identify potentially successful career choices in career counseling (McDaniel & Snell, 1999) and other applied settings (Muchinsky, 1999). More precise coding can be obtained using multiple-letter codes, with the first letter denoting the most salient type, the second letter denoting the second most salient type, and the third letter denoting the third most salient type.

A spatial model for Holland's (1959, 1997) theory was proposed by Holland, Whitney, Cole, and Richards (1969), using a hexagon to represent the distances between the six interest types ordered clockwise, R-I-A-S-E-C. The degree of similarity between the Holland types, as measured by correlations between interest scales, is inversely proportional to the distances between them. In general, spatial models are an intuitive and easily used visual method for representing similarity and can be used to help clients identify potential occupational choices that are linked according to their degree of similarity (Rounds & Day, 1999). The spatial model of RIASEC types facilitates the use of Holland-based scales in career counseling, and the success of Holland's hexagon illustrates the usefulness of this approach (Rayman & Atanasoff, 1999). In addition to providing an interpretive framework for an individual's interests, the RIASEC taxonomy has also been used to measure work environments and as an occupational classification system (L. S. Gottfredson & Richards, 1999). For example, the Occupational Scales of the Strong (Harmon et al., 1994) are organized by Holland type, and comprehensive lists of occupational titles associated with each Holland type are available in the *Dictionary of Holland Occupational Codes* (G. D. Gottfredson & Holland, 1996) and in the U.S. Department of Labor's O*NET database (U.S. Department of Labor, 2003). The American College Testing Program has expanded upon the Holland model by organizing 23 groups of occupations, or job families, into the spatial model of RIASEC types as a World-of-Work Map (Prediger 1982; Swaney, 1995).

Although Holland's (1959, 1997) taxonomy and spatial model is useful for career counseling and in other applied settings, it is not without its limitations. Using six categories produces groups that are very broad, grouping a wide range of occupations with notable differences (Dawis, 1992; L. S. Gottfredson & Richards, 1999; Tracey & Rounds, 1995). Multiple-letter codes can be used to create a more detailed classification (Holland, 1997; McDaniel & Snell, 1999), although the distinctions made between occupations with this technique can appear to be somewhat arbitrary or confusing in some cases. For example, according to the *Dictionary of Holland Occupational Codes* (G. D. Gottfredson & Holland, 1996), some engineers are classified R-I-E, such as automotive or petroleum engineers, whereas others are classified I-R-E, such as electrical or mechanical research engineers. Furthermore, these multiple-code titles are acronyms (RIE and IRE, respectively) that may be of questionable value to individuals who are unfamiliar with the intricacies of the Holland RIASEC system, such as career counseling clients (see Hansen, Kozberg, & Goranson, 1994).

Another limitation of using RIASEC types is the empirical evidence suggesting that six types are not sufficient to represent the complexity of the world of work. In short, comprehensive factor analytic studies of vocational interests have identified more than six factors. Rounds (1995) reviewed this research literature, including studies by Guilford, Christensen, Bond, and Sutton (1954); Jackson (1977); Kuder (1977); Droege and Hawk (1977); and Rounds and Dawis (1979). Of the studies reviewed, the Guilford et al. results are most often cited as support for Holland's types (see Holland, 1997, p. 6). A closer look at the Guilford et al. study, however, revealed 12 factors consistent with a modern understanding of vocational interests, as compared with the seven factors originally identified by Guilford as being relevant to vocational interests. More recent studies also revealed more than six factors. Jackson identified 28 primary and 8 second-order factors, Kuder identified 16 factors, Droege and Hawk identified 11 factors, and Rounds and Dawis identified 14 factors for men and 13 factors for women. On the basis of these results, Rounds (1995) concluded that Holland-based models "do not adequately represent the complexity of the interest space when viewed from the perspective of basic interest dimensions" (p. 177). We propose that a model based on basic interests would be more representative and address the limitations of using the Holland (1959, 1997) RIASEC types.

## Basic Interests and the Strong

The Strong BISs (Campbell et al., 1968) were created to provide interpretive information to enhance the use of the Strong's empirically developed Occupational Scales (E. K. Strong, 1927) by providing insight into the "organization of an individual's choices" (Campbell et al., 1968, p. 54). As discussed by Campbell et al., the Occupational Scales were effective for identifying potential interest in specific occupational titles, but the heterogeneous content of these scales made it difficult to expand the interpretation of results to other occupations. By grouping items into homogenous content areas, the BISs provide a structured, standardized way to begin a discussion of how interests can be expanded beyond the scope of a specific occupation. Despite the potential utility of this approach, basic interests have been neglected in models of vocational interests, possibly because of the emergence of Holland's (1959, 1997) structure as the dominant model in vocational psychology (Campbell & Borgen, 1999; Day & Rounds, 1997).

When examining the validity of the BIS of the 1994 edition of the Strong (Harmon et al., 1994) in comparison with the Holland-based General Occupational Themes, Donnay and Borgen (1996) found the BISs to be the most valid predictors of occupational group membership and concluded that “basic interest scales more effectively deal with the reality of a complex multivariate space” (p. 288). Ralston, Borgen, Rottinghaus, and Donnay (in press) reported similar results demonstrating the increased explanatory power of the Strong BISs (Campbell et al., 1968) over RIASEC scales when examining membership in 24 major fields of education and training. Despite their potential effectiveness in applied settings, the BISs in the 1994 edition of the Strong are described as “subdivisions of the General Occupational Themes” (Harmon et al., 1994, p. 69). When Strong results are presented to individuals, BIS scores are grouped by Holland type, as are the results for the Occupational Scales (E. K. Strong, 1927). In this interpretive framework, basic interests are used to help clarify and specify an individual’s interests in the context of the six Holland (1959, 1997) categories. Although this is a useful application of basic interests, the true potential of these measures may be obscured by the Holland structure. Given the previously discussed limitations of the Holland types, perhaps it is time to develop a new interpretive framework using basic interests as the template.

## Hierarchical and Spatial Models of Interests

Jackson (1977) discussed several advantages to using an occupational cluster system to organize the results of an interest inventory. Jackson pointed out that providing scores for a large number of occupations results in an overwhelming volume of information that is potentially bewildering to a career counseling client. Furthermore, because many occupations are similar, much of the information provided is redundant. By organizing occupations into clusters, the volume of information presented to an individual, and its level of redundancy, is reduced. He argued that the appropriate emphasis in the initial stages of career counseling should be on creating a general understanding of interests, and the use of occupational titles could create a misplaced emphasis on specific occupations. Finally, Jackson noted that even the use of a large number of job titles will still not represent the entire range of jobs that a person could consider and suggested that a clustering system is more likely to provide an efficient representation of a wide range of occupational choices.

An alternative to using the RIASEC coding system would be to develop a set of occupational clusters and assign unique names to each group of occupations. An example of this strategy is the World-of-Work Map, developed by the American College Testing Program (ACT; Swaney, 1995). The ACT World-of-Work Map extends the Holland model in two directions. Extending the theory toward a more generalized level, the RIASEC structure is defined in terms of two underlying dimensions proposed by Prediger (1982): Data–Ideas and People–Things. Extending the theory toward a more specific level, the six RIASEC types are subdivided into 23 uniquely named clusters called *job families*. The hierarchical structure of the ACT World-of-Work Map facilitates transitions in the discussion of vocational interests from general interests to specific groups of occupations, or in the opposite direction, providing different levels of interest information, depending on the varying needs of career counseling clients. And the use of 23 uniquely named clusters is potentially more intuitive than the use of multiple-letter RIASEC codes to identify groups of occupations.

Other researchers have developed sets of occupational clusters to be used in their vocational interest measures. Jackson (1977) developed a list of 32 occupational clusters that are used to organize results from the Jackson Vocational Interest Survey. These occupational clusters are based on an analysis of interest patterns of individuals employed in 278 occupations (see Jackson, 1977, pp. 45–76). The U.S. Department of Labor developed an interest-based hierarchical occupational classification system for one of its publications, the *Guide for Occupational Exploration* (U.S. Department of Labor, 1979). This classification system divides occupations into 12 interest areas and 66 work groups. A number of U.S. government agencies have used different rationally based classification systems, which makes it difficult to compare information from different sources. To address this issue, the Standard Occupational Classification (SOC) system was developed, with the intention that it will be used by all U.S. government agencies that collect work-related data (Levine & Salmon, 1999). The SOC organizes occupations by the type of work activities performed and required skills, education, training, licensing, and credentials. Although it represents a step forward in organizing the occupational information collected by U.S. government sources, a limitation of using the SOC system in career counseling is that its organizational structure does not reflect interests.

Spatial models of vocational interests organize the occupational interests of individuals, presenting these interests in a parsimonious and coherent way. Exposure to information about occupations linked in a spatial model also helps clients see possibilities that were previously outside of their awareness (Rounds & Day, 1999). Some researchers have argued that hierarchical and spatial models of interests should be treated as competing alternatives (see Gati, 1991; Tracey & Rounds, 1993). However, the potential exists to create a model combining information from both hierarchical and spatial analyses (Arabie, Carroll, & DeSarbo, 1987). The effectiveness of this combined approach has been demonstrated by the RIASEC-based two-dimensional ACT World-of-Work Map (Prediger, 1982; Swaney, 1995). Therefore, a logical extension to present RIASEC-based models of occupational structure would be to create a new model using basic interests to develop a hierarchical classification system for occupations and a spatial representation of their structure.

## The Present Study

The primary goal of the present study was to develop an interest-based occupational classification system and a spatial map of occupations using basic interests. The proposed occupational structures rely on the BIS (Campbell et al., 1968) scores for the occupational incumbent samples from the 1994 edition of the Strong (Harmon et al., 1994) and occupational characteristics from the U.S. Department of Labor’s (2003) O*NET database. The occupational incumbent samples of the Strong represent the most extensive set of interest data collected on occupations in the United States and occupational characteristics from the O*NET system database (U.S. Department of Labor, 2003). The merging of data from these two sources represents an important convergence of information and concepts relevant to the career development process. Prior to developing occupational structures, and because we had incumbent samples of men and women for the same occupations, we evaluated the structure of basic interest profiles by gender to determine whether it was reasonable to combine the samples. We then constructed the occupational classification and spatial map using a combination of hierarchical clustering and multidimensional scaling (MDS) techniques. We used property vector fitting analyses using O*NET data to assist in the interpretation of the dimensions of the occupational spatial map and to provide linkages between the Strong (Harmon et al., 1994) and the U.S. Department of Labor's O*NET database of occupational information.

There are a number of potential advantages to the proposed model over the Holland system. In career counseling, the hierarchical classification system would allow for the recommendation of a more or less circumscribed range of occupations to explore, depending on the client's level of career development. The use of basic interests to create the model provides a more sophisticated and representative picture of interest structure. By using a spatial model and linking results to the O*NET database (U.S. Department of Labor, 2003), a wide range of occupational information can be accessed during the counseling process that is relevant to the client's interests. In short, the proposed model could serve as a foundation for developing a more flexible, comprehensive, and representative system for presenting assessment results and related occupational information.

## Method

### Data Sources

An initial sample of 33,594 women and 32,421 men were drawn from the incumbent samples used to develop the Occupational Scales of the 1994 revision of the Strong (Harmon et al., 1994). As outlined in the Strong manual (Harmon et al., 1994, pp. 107–110), *incumbents* are defined as individuals who are successfully employed in an occupation as measured by degree of job satisfaction and tenure and perform typical duties of the occupation. Table 1 includes the list of the occupations represented in the 1994 Strong, with the female and male sample sizes for each occupation. Of the 211 incumbent samples used in the 1994 Strong, 107 are female incumbents and 104 are male incumbents, representing a total of 109 occupations. For 102 occupations, there are both male and female incumbent samples, with 5 occupations having only female samples and 2 occupations having only male samples. In the present study, the analysis was limited to occupations with both male and female incumbent samples. The mean age of incumbent samples for occupations ranges from 27.3 to 61.2 years, with an average of 40.2 years ($SD = 4.8$). The mean number of years of experience for incumbent samples for occupations ranges from 4.6 to 32.3, with an average of 13.7 ($SD = 4.5$). Additional information on the incumbent samples, including year tested, percentages with different levels of education, percentages in different areas of employment, and typical work activities for each occupational sample, is available in the appendix to the Strong manual (Harmon et al., 1994, pp. 310–376).

Data on the characteristics of the occupations represented in the Strong (Harmon et al., 1994) were obtained from Version 4.0 of the O*NET database (U.S. Department of Labor, 2003). The O*NET is the replacement for the *Dictionary of Occupational Titles* (U.S. Department of Labor, 1991) and provides a comprehensive database of information on the occupations in the U.S. labor market, including worker attributes, organizational and work context, work content and outcomes, and trends in the labor market. The O*NET is constructed so that data from the system's career exploration tools can be linked to the database that presently has information for 900 occupations classified into groups using the SOC. Data in the O*NET are at the occupational level, in the form of ratings for each occupation of work environment characteristics and characteristics of the people employed in the occupation. In the first version of the O*NET, data for each occupation were taken from expert ratings; each new version of the database represents an update, with data collected in the workplace (see Hubbard et al., 2000). Although the O*NET system was initially designed for use in government agencies and programs, it is also available for other applications, including career development research, career counseling, and industry-based efforts to facilitate employee development.

### Measures

*BISs.* The 1994 edition of the Strong (Harmon et al., 1994) has 25 measures of basic interests: Agriculture, Nature, Military Activities, Athletics, Mechanical Activities, Science, Mathematics, Medical Science, Music/Dramatics, Art, Applied Arts, Writing, Culinary Arts, Teaching, Social Service, Medical Service, Religious Activities, Public Speaking, Law/Politics, Merchandising, Sales, Organizational Management, Data Management, Computer Activities, and Office Services. Scores on all 25 BISs were obtained for each participant. As reported in the Strong manual (Harmon et al., 1994, pp. 82–90), the mean Cronbach coefficient alpha reliability for these scales was .85 ($SD = .05$), and the average test–retest reliability over a period of 1–6 months, with four samples of college students and adults, was .84 ($SD = .05$).

*O*NET interest measures.* The O*NET database provides interest profiles for each occupation in the database that are compatible with Holland's (1959, 1997) model of personality types and work environments. Scores are provided on six interest categories (R, I, A, S, E, and C) that are used to describe the work environment of occupations.

*O*NET work values.* In the O*NET, work values indicate how likely a value is to be reinforced or satisfied by a particular occupation. Six work value measures, based on value measures from the theory of work adjustment (Dawis & Lofquist, 1984), were obtained from the O*NET database for the present analyses: Achievement, Working Conditions, Recognition, Relationships, Support, and Independence.

*O*NET knowledge areas.* In the O*NET, knowledge measures organized sets of principles and facts applied in general domains. Using information provided in the O*NET content model by Costanza, Fleishman, and Marshall-Mies (1999), 33 knowledge measures were grouped into 12 knowledge areas. *Business and Management* measures level of knowledge of principles and facts related to business administration and accounting. *Manufacturing and Production* measures level of knowledge of principles and facts related to manufactured and agricultural goods. *Engineering and Technology* measures level of knowledge of the design, development, and application of technology for specific purposes. *Mathematics and Science* measures level of knowledge of the physical, biological, and mathematical sciences. *Social Sciences* measures level of knowledge of the social sciences and geography. *Medicine and Dentistry* measures level of knowledge of the information and techniques needed to diagnose and treat human injuries, diseases, and deformities. *Therapy and Counseling* measures level of knowledge of principles, methods, and procedures for diagnosis, treatment, and rehabilitation of physical and mental dysfunctions. *Education and Training* measures level of knowledge of principles and methods for teaching and instruction. *Arts and Humanities* measures level of knowledge of facts and principles related to the branches of learning concerned with human thought, language, and the arts. *Law and Public Safety* measures level of knowledge of regulations and methods for maintaining people and property free from danger, injury, or damage. *Communications* measures level of knowledge of the delivery of information. *Transportation* measures level of knowledge of principles and methods for moving people or goods by air, rail, sea, or road.

*O*NET social skills.* In the O*NET, *social skills* are defined as developed capacities used to work with people to achieve goals. Six measures of social skills were obtained from the O*NET database for the present analyses. *Social Perceptiveness* measures level of being aware of others' reactions and understanding why they react as they do. *Coordination* measures level of adjusting actions in relation to others' actions. *Persuasion* measures level of persuading others to change their minds or behavior. *Negotiation* measures level of bringing others together and trying to reconcile differences. *Instructing* measures level of teaching others how to do something. *Service Orientation* measures level of actively looking for ways to help people.

Table 1
*Male–Female Profile Correlations of Strong Occupations*

| Occupation | Incumbent sample | | |
|---|---|---|---|
| | Female | Male | *r* |
| Accountant | 383 | 881 | .57 |
| Actuary | 642 | 593 | .65 |
| Advertising executive | 205 | 348 | .74 |
| Agribusiness manager | — | 297 | — |
| Architect | 603 | 560 | .79 |
| Art teacher | 360 | 303 | .92 |
| Artist, commercial | 222 | 206 | .86 |
| Artist, fine | 247 | 213 | .94 |
| Athletic trainer | 242 | 250 | .82 |
| Audiologist | 509 | 426 | −.13 |
| Auto mechanic | 165 | 561 | .85 |
| Banker | 283 | 264 | .31 |
| Biologist | 282 | 757 | .89 |
| Bookkeeper | 243 | 116 | .60 |
| Broadcaster | 220 | 213 | .72 |
| Business education teacher | 576 | 545 | .86 |
| Buyer | 214 | 219 | .72 |
| Carpenter | 97 | 199 | .44 |
| Chef | 106 | 296 | .33 |
| Chemist | 271 | 304 | .79 |
| Child care provider | 349 | — | — |
| Chiropractor | 212 | 230 | .44 |
| College professor | 400 | 229 | .57 |
| Community service organization director | 418 | 390 | .45 |
| Computer programmer/systems analyst | 248 | 483 | .84 |
| Corporate trainer | 226 | 232 | .35 |
| Credit manager | 322 | 454 | .35 |
| Dental assistant | 215 | — | — |
| Dental hygienist | 236 | — | — |
| Dentist | 365 | 416 | .43 |
| Dietician | 208 | 108 | .50 |
| Elected public official | 224 | 208 | .64 |
| Electrician | 60 | 260 | .27 |
| Elementary school teacher | 241 | 220 | −.03 |
| Emergency medical technician | 207 | 241 | .61 |
| Engineer | 254 | 512 | .61 |
| English teacher | 303 | 222 | .85 |
| Farmer | 92 | 152 | .38 |
| Flight attendant | 553 | 412 | .74 |
| Florist | 211 | 207 | .61 |
| Food services manager | 180 | 116 | .46 |
| Foreign language teacher | 315 | 251 | .81 |
| Forester | 438 | 921 | .56 |
| Gardener/groundskeeper | 94 | 362 | .46 |
| Geographer | 195 | 277 | .57 |
| Geologist | 212 | 242 | .85 |
| Hair stylist | 181 | 195 | .64 |
| High school counselor | 208 | 266 | .69 |
| Home economics teacher | 312 | — | — |
| Horticultural worker | 155 | 208 | .51 |
| Housekeeping and maintenance supervisor | 577 | 569 | .35 |
| Human resources director | 445 | 496 | .30 |
| Interior decorator | 222 | 214 | .96 |
| Investments manager | 212 | 212 | .47 |
| Lawyer | 551 | 418 | .47 |
| Librarian | 1,187 | 355 | .80 |
| Life insurance agent | 265 | 294 | .67 |
| Marketing executive | 298 | 349 | .56 |
| Mathematician | 213 | 270 | .90 |
| Math teacher | 245 | 226 | .61 |
| Medical illustrator | 99 | 61 | .91 |
| Medical records technician | 395 | 247 | .47 |
| Medical technician | 259 | 233 | .54 |
| Medical technologist | 266 | 206 | .66 |
| Military enlisted | 838 | 817 | .48 |
| Military officer | 801 | 899 | .46 |
| Minister | 250 | 255 | .82 |
| Musician | 209 | 230 | .79 |
| Nurse, LP | 228 | 128 | .84 |
| Nurse, RN | 886 | 703 | .73 |
| Nursing home administrator | 238 | 306 | .25 |
| Occupational therapist | 328 | 388 | .72 |
| Optician | 258 | 213 | .33 |
| Optometrist | 191 | 220 | .25 |
| Paralegal | 488 | 120 | .14 |
| Parks and recreation coordinator | 714 | 900 | .29 |
| Pharmacist | 321 | 370 | .25 |
| Photographer | 249 | 161 | .63 |
| Physical education teacher | 291 | 219 | .75 |
| Physical therapist | 715 | 543 | .55 |
| Physician | 211 | 272 | .72 |
| Physicist | 348 | 483 | .90 |
| Plumber | — | 96 | — |
| Police officer | 116 | 484 | .60 |
| Psychologist | 287 | 318 | .70 |
| Public administrator | 201 | 216 | .70 |
| Public relations director | 403 | 291 | .74 |
| Purchasing agent | 247 | 224 | .38 |
| Radiologic technologist | 543 | 430 | .40 |
| Realtor | 209 | 208 | .69 |
| Reporter | 207 | 208 | .71 |
| Research and development manager | 201 | 215 | .52 |
| Respiratory therapist | 216 | 206 | .60 |
| Restaurant manager | 152 | 192 | .55 |
| School administrator | 347 | 314 | .36 |
| Science teacher | 213 | 237 | .58 |
| Secretary | 269 | — | — |
| Small business owner | 206 | 398 | −.05 |
| Social science teacher | 230 | 224 | .51 |
| Social worker | 488 | 458 | .76 |
| Sociologist | 210 | 212 | .85 |
| Special education teacher | 263 | 221 | .47 |
| Speech pathologist | 425 | 334 | .65 |
| Store manager | 176 | 238 | .57 |
| Technical writer | 350 | 274 | .68 |
| Translator | 475 | 238 | .54 |
| Travel agent | 264 | 214 | .66 |
| Veterinarian | 459 | 327 | .65 |
| Vocational agriculture teacher | 135 | 239 | .40 |

*Note.* Dashes indicate that data were not obtained.

*O*NET technical skills.* In the O*NET, *technical skills* are defined as developed capacities used to design, set up, operate, and correct malfunctions involving application of machines or technological systems. Eleven measures of technical skills were obtained from the O*NET database for the present analyses. *Operations Analysis* measures level of analyzing needs and product requirements to create a design. *Technology Design* measures level of generating or adapting equipment and technology to serve user needs. *Equipment Selection* measures level of determining the kind of tools and equipment needed to do a job. *Installation* measures level of installing equipment, machines, wiring, or programs to meet specifications. *Programming* measures level of writing computer programs for various purposes. *Operation Monitoring* measures level of watching gauges, dials, or other indicators to make sure a machine is working properly. *Operation and Control* measures level of controlling operations of equipment or systems. *Equipment Maintenance* measures level of performing routine maintenance on equipment and determining when and what kind of maintenance is needed. *Troubleshooting* measures level of determining causes of operating errors and deciding what to do about it. *Repairing* measures level of repairing machines or systems using the needed tools. *Quality Control Analysis* measures level of conducting tests and inspections of products, services, or processes to evaluate quality or performance.

*O*NET resource management skills.* In the O*NET, *resource management skills* are defined as developed capacities used to allocate resources efficiently. Four measures of resource management skills were obtained from the O*NET database. *Time Management* measures level of managing one's own time and the time of others. *Management of Financial Resources* measures level of determining how money will be spent to get the work done and accounting for these expenditures. *Management of Material Resources* measures level of obtaining and implementing the appropriate use of equipment, facilities, and materials needed to do certain work. *Management of Personnel Resources* measures level of motivating, developing, and directing people as they work, identifying the best people for the job.

*O*NET work activity areas.* In the O*NET, work activities measure general types of job behaviors that occur across multiple jobs. Using information provided in the O*NET content model and by Jeanneret, Borman, Kubisiak, and Hanson (1999), 41 work activity measures were grouped into nine work activity areas. *Getting Information* measures the level of observing, receiving, and otherwise obtaining information from all relevant sources needed to perform the job. *Evaluating Information* measures the level of interpreting job-relevant information needed to perform the job. *Information Processing* measures the level of information processing that is done to perform the job. *Decision Making* measures the levels of reasoning, decision making, and problem solving that are done to perform the job. *Physical Activities* measures the level of activities using the body and hands that are done to perform the job. *Technical Activities* measures the level of skilled activities using coordinated movements that are done to perform the job. *Communicating* measures the level of interactions with other people that occur while performing the job. *Coordinating* measures the level of coordinating, managerial, or advisory activities that are done while performing the job. *Administering* measures the level of administrative activities that are done while performing the job.

*O*NET work context areas.* In the O*NET, work context measures the physical and social factors that influence the nature of work. Using information provided in the O*NET content model and by M. H. Strong, Jeanneret, McPhail, Barkley, and D'Egidio (1999), 26 work context measures were grouped into eight work context areas. *Interpersonal Contact* measures the amount of various forms of interpersonal communication that occur on the job. *Responsibility* measures the amount of responsibility the worker has for other workers as a part of this job. *Conflictual Contact* measures the amount of conflict that the worker will encounter as part of this job. *Indoor Work* measures how often the job requires working indoors in environmentally controlled conditions. *Outdoor Work* measures how often the job requires working outdoors, exposed to all weather conditions. *Unpleasant Work Conditions* measures the context of extreme environmental conditions the worker will be placed in as part of the job. *Hazardous Conditions* measures the frequency of exposure and degree of injury if exposed to hazardous conditions on the job. *Automation* measures the degree of automation involved in performing the job.

## Statistical Analyses

*Comparison of male and female BIS profiles.* Prior to developing a hierarchical classification system and a spatial model for the occupations represented by the Strong (Harmon et al., 1994), the question of differences in the BIS profiles was examined for the incumbent samples of men and women successfully employed within the same occupation. That is, consideration was given as to whether to distinguish between female and male specific occupations (e.g., female dentist, male dentist, female accountant, male accountant, and so forth) or whether it was appropriate to combine scores from the incumbent samples of each gender for a given occupation. This decision has important implications for the interpretability of the model being developed because the use of unisex incumbent samples will cut in half the number of data points to represent hierarchically and spatially. However, it is only appropriate to create these unisex representations of occupations if the BIS profiles of male and female incumbents are similar. To assess the similarity of BIS profiles by gender, Pearson product–moment correlations were calculated for each male–female sample pair using BIS scores. A Pearson correlation provides a measure of the similarity of shape of the BIS profiles of male and female incumbent samples, with larger values indicating a more similar shape (Cronbach & Gleser, 1953).

*Cluster analysis of occupations.* Three agglomerative methods of hierarchical cluster analysis, complete-linkage, single-linkage, and average-linkage, were used to identify groups of occupations based on degree of similarity of basic interest profiles. Complete-linkage, single-linkage, and average-linkage clustering methods each seek to group the occupations into a series of hierarchically related clusters, in which members of any particular cluster are as homogenous as possible, and members of distinct clusters are as heterogeneous as possible. The resulting hierarchy can be represented by a dendrogram (tree structure). The three clustering methods used in this study differ in the manner in which they define agglomeration levels, and thus differ in the hierarchies that typically result (Aldenderfer & Blashfield, 1984). The single-linkage method identifies clusters by joining cases (i.e., occupations) if the case under consideration is of the same level of similarity as at least one member in an existing cluster, and it tends to produce long, stringy clusters. The complete-linkage method identifies clusters by joining cases if the case under consideration is of the same level of similarity as all members of an existing cluster, and it tends to produce compact, tightly grouped clusters. Finally, the average-linkage method identifies clusters by joining cases if the case under consideration is of the same level of similarity as the average of the members of an existing cluster, producing a cluster solution midway between single- and complete-linkage clustering in these respects. Because no single clustering method is capable of providing a single, definitive partitioning, a consensus clustering on the basis of comparing results obtained with several methods is an appropriate solution.

*Spatial representation of occupations.* The method of nonmetric MDS (Kruskal & Wish, 1978) was used to develop a spatial representation of the occupations represented by incumbent samples, analyzing the same matrix of interoccupation correlations used for the hierarchical clustering analyses. MDS is a statistical technique used to develop a spatial representation of a set of objects, in this case the occupations of the Strong (Harmon et al., 1994). MDS techniques seek to represent the occupations in a dimensional space so that for any pair of objects, the interoccupational distance within that space corresponds to the measured similarity between that pair of occupations. This technique provides a framework for understanding and interpreting the structure of interests by distilling the interrelations between occupations described by a large number of correlations into a small number of underlying dimensions. MDS facilitates a dimensional interpretation of the structure of interests because explanatory dimensions can be posited, either through visual assessment of the MDS solution or through empirical techniques such as property vector fitting. Because of the large number of occupations to represent in the spatial model, points representing groups of occupations (rather than individual occupations) identified in the cluster analysis were plotted by calculating mean coordinate values for the occupations in each cluster.

*Property vector fitting.* The technique of property vector fitting (Kruskal & Wish, 1978) was used to facilitate the process of labeling interest dimensions created in the MDS analysis of the Strong (Harmon et al., 1994) occupations. The first step in property vector fitting is to determine a set of coordinates to represent the interest structure being represented. Coordinates were obtained by integrating the clustering analysis results into the MDS results. The locations of the nine interest areas and 19 occupational clusters in the interest structure were calculated by taking the mean coordinate values in the MDS solution for the occupations in each interest area and occupational cluster. The second step is to calculate scores for each measured characteristic, or property, associated with the occupations being scaled. To do this, occupational titles from the Strong were matched to occupations from the O*NET database, and mean scores on the O*NET measures of interests; values; knowledge areas; social, technical, and resource management skills; work activities; and work contexts were calculated for each interest area. The third step is to use a linear multiple regression procedure to regress scores for each property onto the coordinates for the interest areas and to estimate the extent to which the property fits into the interest structure. The salience of the property in terms of the RIASEC structure is assessed by the variance accounted for (as measured by $R^2$) in the multiple regression procedure. The final step is to use this information to create a visual representation of the interrelations between characteristics and the interest structure. Characteristics that achieved $R^2$ values greater than .50 were included in figures. The property vector is illustrated as a line emerging from the origin of the MDS coordinate system that points in the direction of the strongest association between the characteristic and an interest area. Interest areas in the opposite direction from the property vector have a negative association with the characteristic. By examining the location of different properties in the interest structure, it is possible to identify the nature of the dimensions of interests that underlie the interrelations among occupations represented by the Strong.

## Results and Discussion

### *Gender Differences in BIS Profile Shape*

The correlations between male and female incumbent sample BIS profiles for each occupation are presented in Table 1. The mean correlation between male and female incumbent samples was .58 ($SD$ = .22), with a minimum correlation of −.13 (audiologist) and a maximum correlation of .96 (interior decorator). Overall, these results indicated that the shape of BIS profiles is similar for the male and female incumbents of the occupations represented in the Strong (Harmon et al., 1994). Although this suggests that the interest profiles of men and women successfully employed in different occupations are similar, it should be noted that a few occupations showed low ($r < .20$) correlations. Audiologist ($r = -.13$), paralegal ($r = .14$), and small business owner ($r = -.05$) showed low intergender correlations, and on this basis, we chose to exclude these occupations from the remaining analyses. Another occupation, elementary school teacher, also showed a low intergender correlation ($r = -.03$), but we chose to retain this occupation in remaining analyses because of a lack of similar occupations in the sets of incumbent samples. In addition to the excluded occupations with low intergender correlations, there were a number of occupations for which an incumbent sample for only one gender was available. Five of these occupations had data only for women (home economics teacher, dental assistant, dental hygienist, secretary, and child care worker); two occupations had data only for men (agribusiness manager and plumber). We also excluded these occupations from subsequent analyses, producing a final dataset of 198 incumbent samples representing 99 occupations, with a final sample size of 31,010 women and 32,421 men.

### *Strong Occupational Classification System*

By comparing the results of the average-linkage, complete-linkage, and single-linkage clustering analyses, we grouped the 99 occupations into a hierarchical taxonomy, the Strong Occupational Classification System. At the first level of aggregation, we identified 19 categories, referred to as o*ccupational clusters*: applied arts, verbal communication, financial detail, office administration, retail sales and management, body work, medical–technical support, medical science, entrepreneurial, media, protective, applied mathematics, physical sciences, social sciences, service arts, agriculture, skilled trades, social administration and guidance, and teaching and helping. We grouped these 19 occupational clusters into nine broader categories referred to as *interest areas*: arts, business, health services, influencing, protective, science, service arts, skilled labor, and social service. In two cases, service arts and protective, the process of grouping occupational clusters into interest areas produced interest areas with only one occupational cluster, so a common name was used at both levels of the hierarchical classification system. A listing of the occupations in each cluster organized by interest area is presented in Table 2.

*Arts interest area.* The arts interest area consists of two occupational clusters: applied arts and verbal communication. Both of these clusters appear to be related to the Artistic type defined by Holland (1997); however, there is a clear distinction between those occupations in which creative expression is achieved through visual and other traditional artistic media and those occupations in which expression is achieved verbally. Most of the occupations in the applied arts cluster involve the creative manipulation of visual media. Occupations in this cluster score high on the Strong BISs (Campbell et al., 1968) of Art, Applied Arts, and Music/Dramatics and score low on Organizational Management, Data Management, Computer Activities, and Office Services. The occupations in the verbal communication cluster reflect an interest in different aspects of verbal communication, with high scores on Writing and low scores on Athletics.

*Business interest area.* The business interest area consists of three occupational clusters: financial detail, office administration, and retail sales and management. This interest area represents a combination of aspects of the Enterprising and Conventional types identified by Holland (1997). Occupations in the financial detail cluster primarily involve working with numbers in a financial or other business context. These occupations score high on the Strong BIS (Campbell et al., 1968) of Organizational Management, Data Management, and Office Services, which suggests an interest in the more conventional aspects of the business world. Occupations in the retail sales and management cluster involve retail sales, purchasing, and management; these occupations score high on Merchandising, Sales, and Organizational Management. Occupations in the office administration cluster represent an interest in working in administrative positions that may involve some sales activity, with high scores on Office Services, Sales, and Merchandising.

*Health services interest area.* Health services consists of three clusters: body work, medical–technical support, and medical science. These groups represent most of the occupations in the Strong (Harmon et al., 1994) that are related to various forms of health services and represent a cross-section of the various levels of work available in this area. The occupations in the body work cluster represent a group related to Medical Science, working primarily on

Table 2
*Strong Occupational Classification: Interest Areas and Occupational Clusters*

| Interest area | Occupational cluster | Occupation title | Interest area | Occupational cluster | Occupation title |
|---|---|---|---|---|---|
| Arts | Applied arts | Architect | Influencing (*continued*) | Media | Advertising executive |
| | | Art teacher | | | Broadcaster |
| | | Artist, commercial | | | Public relations director |
| | | Artist, fine | | | Reporter |
| | | Medical illustrator | Protective | Protective | Military enlisted |
| | | Musician | | | Military officer |
| | | Photographer | | | Police officer |
| | Verbal communication | Librarian | Science | Applied mathematics | Actuary |
| | | Technical writer | | | Computer programmer/systems analyst |
| | | Translator | | | Engineer |
| Business | Financial detail | Accountant | | | Mathematician |
| | | Banker | | | Math teacher |
| | | Bookkeeper | | | Research and development manager |
| | | Business education teacher | | Physical sciences | Biologist |
| | | Credit manager | | | Chemist |
| | Office administration | Food services manager | | | Geologist |
| | | Housekeeping and maintenance supervisor | | | Physicist |
| | | Medical records technician | | Social sciences | College professor |
| | | Nursing home administrator | | | Geographer |
| | Retail sales and management | Buyer | | | Psychologist |
| | | Life insurance agent | | | Sociologist |
| | | Optician | Service Arts | Service arts | Chef |
| | | Purchasing agent | | | Dietician |
| | | Realtor | | | Flight attendant |
| | | Restaurant manager | | | Florist |
| | | Store manager | | | Hair stylist |
| | | Travel agent | | | Interior decorator |
| Health services | Body work | Athletic trainer | Skilled labor | Agriculture | Farmer |
| | | Occupational therapist | | | Forester |
| | | Physical education teacher | | | Gardener/groundskeeper |
| | | Physical therapist | | | Horticultural worker |
| | Medical–technical support | Chiropractor | | | Vocational agriculture teacher |
| | | Emergency medical technician | | Skilled trades | Auto mechanic |
| | | Medical technician | | | Carpenter |
| | | Nurse, LP | | | Electrician |
| | | Nurse, RN | Social service | Social administration and guidance | Community service organization director |
| | | Radiologic technologist | | | High school counselor |
| | | Respiratory therapist | | | Parks and recreation coordinator |
| | Medical science | Dentist | | | School administrator |
| | | Medical technologist | | | Social science teacher |
| | | Optometrist | | Teaching and helping | Elementary school teacher |
| | | Pharmacist | | | English teacher |
| | | Physician | | | Foreign language teacher |
| | | Science teacher | | | Minister |
| | | Veterinarian | | | Social worker |
| Influencing | Entrepreneurial | Corporate trainer | | | Special education teacher |
| | | Elected public official | | | Speech pathologist |
| | | Human resources director | | | |
| | | Investments manager | | | |
| | | Lawyer | | | |
| | | Marketing executive | | | |
| | | Public administrator | | | |

issues related to physical motion such as physiotherapist and athletic trainer. Similar to other clusters in this interest area, this group scores high on both Medical Science and Medical Service but also scores very high on Athletics. Occupations in the medical–technical support cluster assist and otherwise provide technical support for medical practitioners and also some types of therapists. This group scores high on both Medical Science and Medical Service but scores higher on Medical Service than on Medical Science. Occupations in the medical science cluster represent medical practitioners and some other occupations with similar interest patterns (medical technologist, science teacher). Occupations in this cluster score high on Medical Science and Medical Service. In comparison with the medical–technical support cluster, this group scores higher on Medical Science than on Medical Service.

*Influencing interest area.* The influencing interest area consists of two occupational clusters: entrepreneurial and media. Occupations in this interest area involve persuading or influencing others. The key element that groups these occupations appears to be an interest in persuading others, which would account for the combination of business and media occupations present in this interest area. Occupations in the entrepreneurial cluster include lawyer, some business management and training occupations, and public official. Occupations in this cluster appear to combine influencing others with entrepreneurial business activity and score high on Public Speaking, Law/Politics, and Organizational Management. Occupations in the media cluster include those involved in broadcasting and related occupations that also may involve knowledge and use of mass media to sell ideas and products. Occupations in this cluster score high on measures of Writing and Public Speaking and score low on Science, Mathematics, and Computer Activities. These scores indicate a strong interest in verbal activities and a lack of interest in working with numbers or data.

*Protective interest area.* The protective interest area consists of a single occupational cluster (protective) that was given the same title. As is the case with the social service interest area, the protective group of occupations was considered to be a unique interest area because of the nature of the occupations and their scores on the Strong BISs (Campbell et al., 1968). Occupations in this cluster—police officers and military personnel—are those that involve protecting people and require knowledge of weapons. These occupations score very high on the Military Activities BIS, but they also score high on Computer Activities and Office Management, which may reflect an interest in order and structure.

*Science interest area.* The science interest area consists of three occupational clusters: applied mathematics, physical sciences, and social sciences. These occupational clusters represent occupations with a strong interest in scientific and other analytical activities. Occupations in the applied mathematics cluster represent an interest in quantitative activities related to science and mathematics, including engineer, actuary, and mathematician. This group also scores high on Mathematics and Science. Occupations in the physical sciences cluster represent the physical sciences such as biologist and geologist. These occupations scored high on Science and Mathematics and scored low on Social Service, Merchandising, Organizational Management, and Merchandising. Occupations in the social sciences cluster represent those in the social sciences, including geographer, psychologist, and sociologist, as well as the more general job title of college professor. This group scores high on the Writing and low on the Athletics and Medical Service BISs.

*Service arts interest area.* The service arts interest area consists of a single occupational cluster (service arts), which was given the same title. Occupations in this cluster, including hair stylist, florist, and interior decorator, generally involve providing personal services in a creative way. The term *service arts* is used to reflect the combination of personal service and artistry that appear to link these occupations. Occupations in this cluster score high on Culinary Arts, Merchandising, and Sales.

*Skilled labor interest area.* The skilled labor interest area consists of two occupational clusters: agriculture and skilled trades. Both of these clusters reflect occupations traditionally classified as Realistic by Holland (1997); however, there does appear to be a clear split between occupations that involve building or maintenance and occupations that involve nature and working outdoors. The occupations in the skilled trades cluster reflect areas of the labor market that require skills training but not necessarily high levels of formal education. In comparison with some of the other interest areas, the range of occupations representing the skilled labor area is smaller, reflecting the Strong's (Harmon et al., 1994) orientation toward university students. The agriculture cluster represents occupations in the skilled labor interest area that involve working with plants and animals. These occupations score very high on Agriculture and Nature and score low on Writing and Music/Dramatics. The skilled trades cluster scored very high on Mechanical Activities, scored high on Agriculture, and scored low on Writing and Organizational Management.

*Social service interest area.* The social service interest area consists of two occupational clusters: social administration and guidance and teaching and helping. Occupations in this interest area involve working with and helping people in educational and community settings. The occupations in these two clusters reflect an interest in a variety of activities that are traditionally associated with the Social type in Holland's (1997) theory. However, these occupations fall short of representing the entire range of occupations in the Social type because medical occupations such as nursing and occupational therapist are not included. Occupations in the social administration and guidance cluster involve the more administrative aspects of the social service working environments. Like the teaching and helping cluster, occupations in this group score high on both Teaching and Social Service; however, the overall profile is somewhat different because of relatively higher scores on Organizational Management, Data Management, and Public Speaking. The teaching and helping cluster includes occupations that offer opportunities for individuals to teach children, languages, or help people deal with a variety of developmental and personal issues. Occupations in this cluster score high on Teaching, Social Service, and Religious Activities. Low scores on Mathematics and Data Management suggest that in addition to having a preference for working with people, individuals in this cluster dislike working with numbers and data.

## *The Strong Ring*

We assessed the goodness of fit of the MDS solutions using an $R^2$ measure of variance accounted for, with higher values indicating a better fit, and Kruskal's stress value (Form 1), with lower values indicating a better fit (Kruskal & Wish, 1978). The variance accounted for by a two-dimensional solution for the 99 Strong occupations was .74, with a stress value of .21. In comparison, the variance accounted for by a three-dimensional solution was .87, with a stress value of .12; values for a four-dimensional solution were .94 and .07, respectively. On the basis of this information, and on a visual inspection of the solutions, we determined that a three-dimensional spatial representation of the occupational structure was most appropriate. Using the results of the three-dimensional MDS solution, we then calculated coordinates for the nine interest areas and 19 occupational clusters identified in the cluster analysis results. When represented in a three-dimensional structure, the occupations of the Strong (Harmon et al., 1994) create a circular, ringlike structure called the *Strong Ring*. The circular aspect of this structure is demonstrated in Figure 1, which illustrates the interrelations among interest areas and occupational clusters on Dimensions 1 and 2. Figure 2 illustrates the interrelations among interest areas and occupational clusters on Dimensions 1 and 3. Figure 3 illustrates these interrelations on Dimensions 2 and 3.

Of the 99 Strong (Harmon et al., 1994) occupations included in the analyses, 85 were matched to occupations in the O*NET

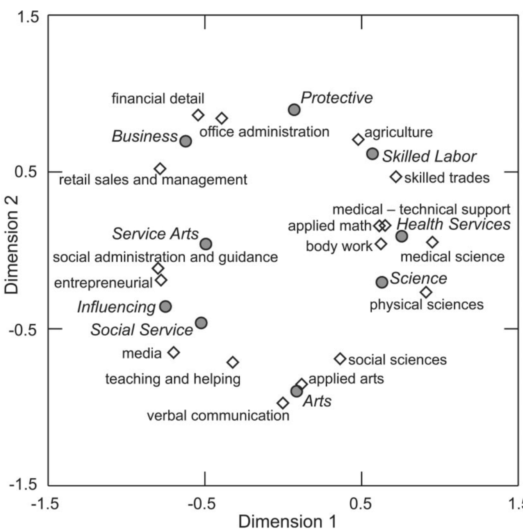


*Figure 1.* Interest areas (solid circles) and occupational clusters (open diamonds) for Dimensions 1 and 2.

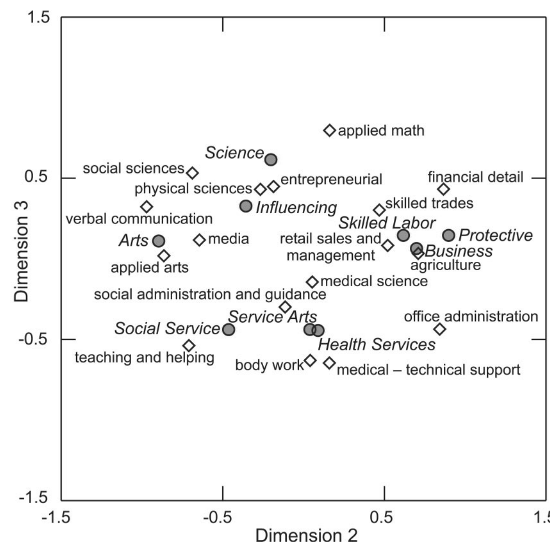


*Figure 3.* Interest areas (solid circles) and occupational clusters (open diamonds) for Dimensions 2 and 3.

database. We calculated scores for each of the 62 O*NET variables used in the present analyses for the nine interest areas for use in the property vector fitting analyses. The results of these analyses, including $R^2$ values and the dimensional loadings for each vector, are presented in Table 3. A total of 40 property vectors representing O*NET variables achieved $R^2$ values greater than .50. Figure 4 illustrates some of the O*NET property vectors with substantial loadings on Dimensions 1 and 2. For example, the O*NET measures of unpleasant work environment and physical activity point toward the skilled labor interest area and away from the influencing and social service interest areas. In comparison, personnel management and time management point toward the influencing and social service interest areas and away from the skilled labor interest area. These results illustrate the nature of the relations between the Strong Ring structure and the O*NET characteristics (physical activity is associated with skilled labor but not social service, personnel management is associated with influencing but not skilled labor, etc.). Figure 5 illustrates some of the O*NET property vectors with substantial loadings on Dimensions 1 and 3, and Figure 6 illustrates some of the O*NET property vectors with substantial loadings on Dimensions 2 and 3.

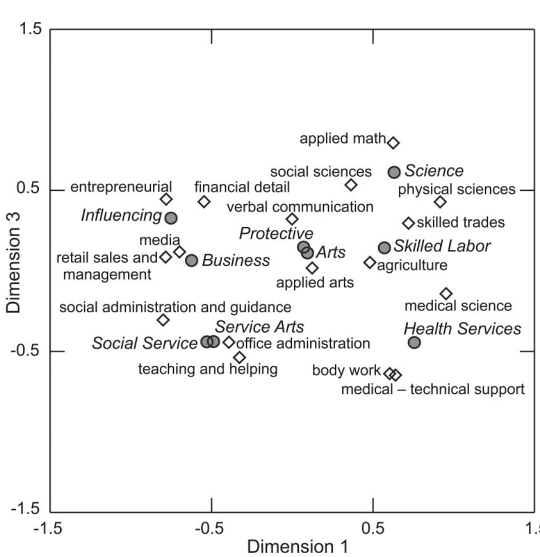


*Figure 2.* Interest areas (solid circles) and occupational clusters (open diamonds) for Dimensions 1 and 3.

*Dimension 1: Persuasion Versus Problem Solving.* As illustrated in Figures 4 and 5, the first dimension of the Strong Ring represents a continuum of interest in working environments ranging from occupations that involve social interaction in business settings, such as life insurance agents and restaurant managers, to those that involve scientific investigation and applications, such as biologists and foresters. To reflect this contrast in preferred working environment, the term *Persuasion Versus Problem Solving* is used to refer to Dimension 1 of the Strong Ring. The Persuasion end of Dimension 1 reflects interests in business-related activities, especially those that involve management and influencing others. This corresponds to aspects of the Enterprising type identified by Holland (1997). The O*NET knowledge area of business was strongly associated with the Persuasion end of this interest dimension, which reflects the business occupations located near the Persuasion dimension in the Strong Ring interest structure. The social skills of persuasion and negotiation and the work context of interpersonal contact that load on this dimension provide some indication of the nature of social contact associated with occupations in this area. The resource management skills and administrative work activities also associated with Dimension 1 indicate that managerial responsibility is also part of this dimension. Occupations from the interest areas of influencing, business, and social service reflect this interest dimension. More specifically, individuals with persuasion interests should consider occupations in the social administration and guidance, retail sales and management, entrepreneurial, and media occupational clusters.

In comparison with the Persuasion end of Dimension 1, the Problem-Solving end reflects interests that do not involve business activities. Instead, individuals in this area prefer scientific investigation and applications of technology. This corresponds to as-

Table 3
*Property Vector Fitting Results*

| O*NET property | $R^2$ | Dim. 1 | Dim. 2 | Dim. 3 |
|---|---|---|---|---|
| Interest | | | | |
| Realistic | .84 | 0.90 | 0.41 | −0.17 |
| Investigative | .64 | 0.83 | −0.58 | 0.04 |
| Artistic | .83 | −0.15 | −0.92 | −0.35 |
| Social | .50 | −0.43 | −0.12 | −0.89 |
| Enterprising | .83 | −0.95 | 0.31 | 0.07 |
| Conventional | .53 | −0.42 | 0.37 | 0.83 |
| Value | | | | |
| Achievement | .71 | 0.30 | −0.90 | −0.33 |
| Working conditions | .39 | −0.18 | −0.65 | 0.74 |
| Recognition | .22 | −0.78 | −0.59 | −0.23 |
| Relationships | .82 | 0.01 | 0.07 | −1.00 |
| Support | .58 | −0.57 | 0.56 | 0.60 |
| Independence | .78 | −0.07 | −0.95 | 0.32 |
| Knowledge area | | | | |
| Business | .65 | −0.98 | 0.10 | 0.19 |
| Manufacturing | .04 | 0.25 | 0.63 | 0.73 |
| Engineering and tech. | .74 | 0.62 | −0.18 | 0.77 |
| Math and science | .74 | 0.99 | −0.13 | −0.11 |
| Social science | .10 | −0.52 | 0.27 | 0.81 |
| Medicine and dentistry | .59 | 0.39 | 0.25 | −0.89 |
| Therapy | .32 | 0.09 | −0.03 | −1.00 |
| Education | .42 | −0.45 | −0.66 | −0.60 |
| Arts and humanities | .70 | −0.22 | −0.89 | 0.40 |
| Law and public safety | .39 | −0.10 | 0.76 | 0.64 |
| Communications | .55 | −0.39 | −0.35 | 0.85 |
| Transportation | .57 | −0.22 | 0.97 | 0.13 |
| Social skill | | | | |
| Social perceptiveness | .33 | −0.67 | 0.07 | −0.74 |
| Coordination | .46 | −0.98 | −0.14 | 0.12 |
| Persuasion | .56 | −0.99 | 0.12 | −0.09 |
| Negotiation | .68 | −0.92 | 0.31 | 0.25 |
| Instructing | .35 | −0.08 | −0.55 | −0.83 |
| Service orientation | .50 | −0.29 | 0.22 | −0.93 |
| Resource management skill | | | | |
| Time management | .53 | −0.75 | −0.65 | 0.12 |
| Management of financial res. | .56 | −1.00 | −0.06 | 0.04 |
| Management of material res. | .35 | −0.78 | −0.22 | −0.59 |
| Management of personnel res. | .55 | −0.92 | −0.37 | 0.19 |
| Technical skill | | | | |
| Operations analysis | .40 | 0.03 | −0.78 | 0.63 |
| Technology design | .69 | 0.91 | −0.37 | 0.19 |
| Equipment selection | .72 | 0.89 | −0.45 | −0.10 |
| Installation | .40 | 0.95 | 0.03 | 0.30 |
| Programming | .53 | 0.23 | −0.37 | 0.90 |
| Operation monitoring | .82 | 0.95 | −0.02 | −0.31 |
| Operation and control | .86 | 0.98 | 0.17 | −0.14 |
| Equipment maintenance | .71 | 0.93 | 0.37 | −0.05 |
| Troubleshooting | .77 | 0.91 | 0.15 | 0.38 |
| Repairing | .51 | 0.88 | 0.40 | 0.27 |
| Quality control analysis | .55 | 0.86 | −0.40 | 0.33 |
| Work activity area | | | | |
| Getting information | .19 | 0.10 | −0.34 | 0.94 |
| Evaluating information | .66 | 0.65 | 0.22 | 0.73 |
| Information processing | .23 | −0.05 | 0.23 | 0.97 |
| Decision making | .43 | −0.26 | −0.59 | 0.76 |
| Physical activity | .73 | 0.75 | 0.63 | −0.18 |
| Technical activity | .83 | 0.48 | −0.03 | 0.88 |
| Communication | .18 | −0.91 | 0.38 | 0.16 |
| Coordination | .33 | 0.63 | −0.53 | 0.57 |
| Administration | .52 | −0.75 | −0.05 | 0.66 |
| Work context area | | | | |
| Interpersonal contact | .51 | −0.70 | 0.33 | −0.63 |
| Conflictual contact | .27 | −0.46 | 0.88 | −0.11 |
| Responsibility | .51 | 0.21 | 0.70 | −0.68 |
| Indoor work | .43 | −0.51 | −0.62 | −0.51 |
| Outdoor work | .36 | 0.41 | 0.65 | 0.64 |
| Unpleasant work conditions | .56 | 0.57 | 0.79 | 0.24 |
| Hazardous conditions | .76 | 0.71 | 0.66 | −0.27 |
| Automation | .45 | 0.92 | 0.24 | 0.31 |

*Note.* Dim. = Dimension; tech. = technician; res. = resources.

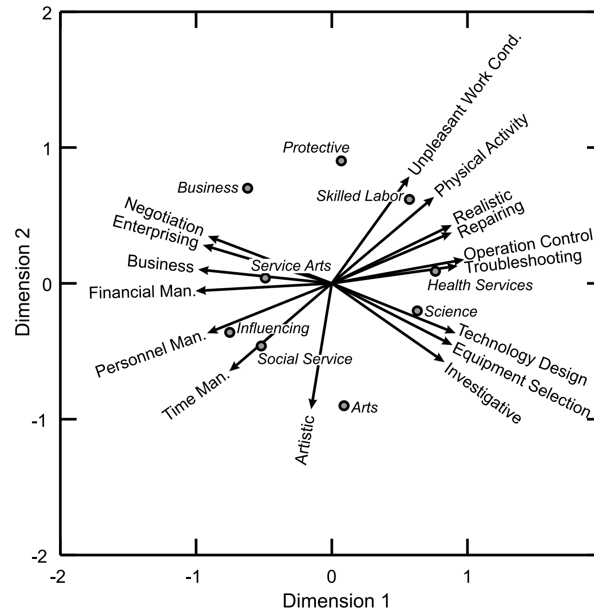


*Figure 4.* Integration of O*NET characteristics into the Strong Ring for Dimensions 1 and 2. Italicized terms represent interest areas. Cond. = Condition; Man. = Management.

pects of both the Investigative and Realistic types identified by Holland (1997). The knowledge area of math and science was associated with the Problem-Solving end of this dimension, which reflects the scientific aspects of this dimension. The work activity area of physical activity and many of the technical skills in our analyses were also associated with Problem Solving. The occupations from interest areas of science, health services, and skilled labor reflect this interest dimension. In particular, individuals with interests of this nature should consider exploring occupations in the physical sciences, skilled trades, and medical science occupational clusters.

*Dimension 2: Structured Versus Dynamic.* As illustrated in Figures 4 and 6, Dimension 2 of the Strong Ring represents a continuum of interests ranging from occupations that involve working in organized or structured environments, such as medical records technicians and military personnel, to occupations that involve working in more dynamic or unstructured environments, such as musicians and artists. To reflect this contrast in preferred working environments, the term *Structured Versus Dynamic* is used to refer to Dimension 2 of the Strong Ring. The Structured end of Dimension 2 reflects a preference for work that has clearly defined activities and responsibilities. This corresponds to some elements of the Realistic and Conventional types from Holland's (1997) theory, although the O*NET measure of the Realistic type was more strongly associated with Dimension 1 of the Strong Ring, and the measure of the Conventional type was more strongly associated with Dimension 3. The transportation knowledge area, physical activity–work activity area, the unpleasant work conditions, and responsibility work contexts were associated with the Structured end of Dimension 2. Occupations in the protective interest area and the occupational clusters of financial detail, agriculture, and office administration should be considered by individuals with an interest in working in more structured work environments.

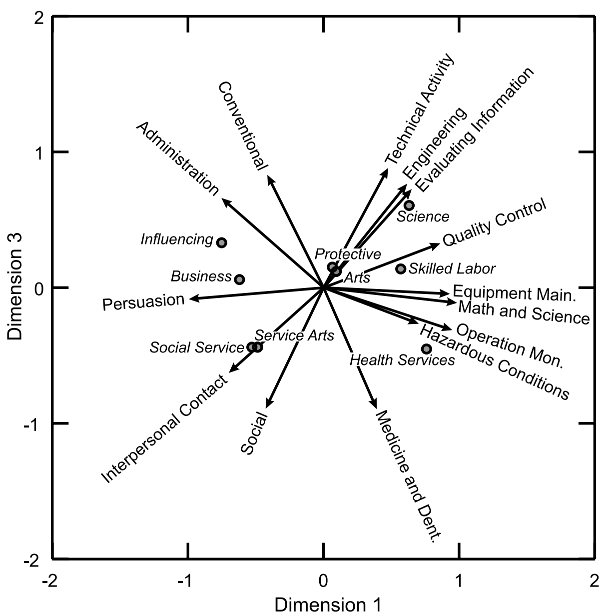


*Figure 5.* Integration of O*NET characteristics into the Strong Ring for Dimensions 1 and 3. Italicized terms represent interest areas. Main. = Maintenance; Mon. = Monitoring; Dent. = Dentistry.

In comparison with the Structured end of Dimension 2 of the Strong Ring, individuals at the Dynamic end prefer working in environments that are more flexible and allow for creative expression. This corresponds to the Artistic type identified by Holland (1997). The O*NET knowledge area of arts and humanities was associated with the Dynamic end of Dimension 2, which reflects the content area of the occupations in this region of the Strong Ring. The work values of achievement and independence were strongly associated with the Dynamic end of Dimension 2, which reflects the self-directed or individualistic element in work of this nature. Occupations in the applied arts, verbal communication, social sciences, and teaching and helping occupational clusters reflect this interest dimension and should be explored by individuals with an interest in a dynamic work environment.

*Dimension 3: Social Service Versus Solitary Work.* As illustrated in Figures 5 and 6, Dimension 3 of the Strong Ring represents a range of work environments from occupations that involve working with others in a helping or teaching capacity, such as nurses and special education teachers, to occupations that involve working individually and often with computers, such as accountants and actuaries. To reflect this contrast in preferred working environments, the term *Social Service Versus Solitary Work* is used to refer to Dimension 3 of the Strong Ring. The O*NET knowledge area of medicine and dentistry, social skill of service orientation, work context of interpersonal contact and responsibility, and the value of relationships all reflect the interpersonal helping nature of the Social Service end of Dimension 3, particularly in comparison with the interpersonal Persuasion of Dimension 1. Individuals with social service interests should consider exploring occupations in the teaching and helping, body work, and medical–technical support occupational clusters.

In comparison with Social Service, in which individuals prefer working with and helping others, the Solitary Work end of Dimension 3 reflects a preference for autonomous work with little social interaction. This reflects some aspects of the Conventional type identified by Holland (1997). The knowledge areas of engineering and technology and communications were associated with solitary work and reflect the technological aspect of this dimension, as do the technical skill of programming and the work activity areas of technical activity and evaluating information. Individuals with a strong interest in working alone should consider occupations in the applied mathematics occupational cluster.

*Nonsignificant property fitting results.* It is also worth considering the implications of property vectors that did not achieve $R^2$ values greater than .50. These O*NET variables did not fit well with the structure of occupations obtained in the present study and may reveal some of the limitations of the present model. Aside from interests, there were measures from each type of O*NET content area that did not fit well in the occupational structure: the values of working conditions and recognition; the knowledge areas of manufacturing, social science, therapy, education, and law and public safety; the social skills of social perceptiveness, coordination, and instructing; the resource management skill of management of material resources; the technical skill of operations analysis; the work activity areas of getting information, information processing, decision making, communication, and coordination; and the work context areas of conflictual contact, indoor work, outdoor work, and degree of automation. In some cases, such as the values of working conditions and recognition or the work activity areas of getting information, these results may reflect the fact that the measure is important across a wide range of interest areas. In other cases, such as the knowledge area of manufacturing or the work context of degree of automation, these results may reflect the range of occupations represented by the Strong (Harmon et al., 1994), which is generally limited to professional occupations that require either postsecondary college education or other types of technical training.

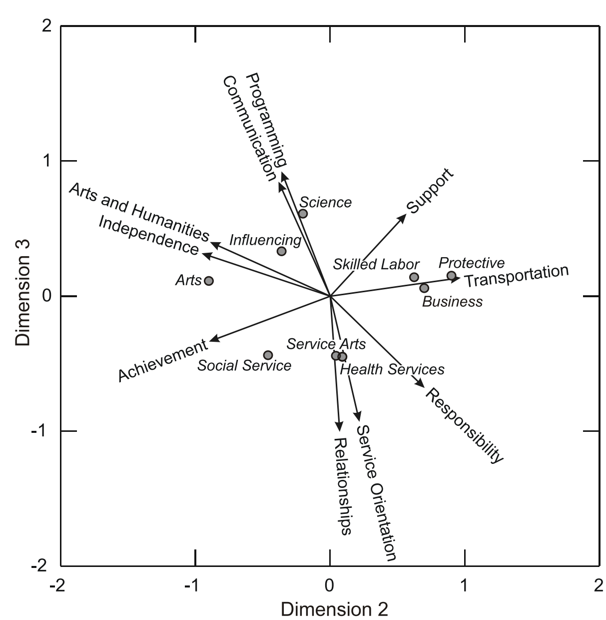


*Figure 6.* Integration of O*NET characteristics into the Strong Ring for Dimensions 2 and 3. Italicized terms represent interest areas.

## Summary and Conclusions

We developed a model of vocational interests using the incumbent samples of the occupations of the Strong (Harmon et al., 1994) and analyzed it using a combination of hierarchical clustering, MDS, and property vector fitting. This model is presented at three levels of aggregation: 99 individual occupational titles, 19 occupational clusters, and nine interest areas. This hierarchical model is referred to as the Strong Occupational Classification System. The interrelations among occupational clusters and interest areas are represented by a three-dimensional structure. When represented in a three-dimensional structure, the occupations used in the Strong create a circular, ringlike shape referred to as the Strong Ring. We investigated and interpreted the three dimensions that form the foundation for this new vocational interest structure through a series of property vector fitting analyses, with data obtained from the U.S. Department of Labor's (2003) O*NET database. The first dimension represents a range of interests in working environments from Persuasive, which involves social interaction in business settings such as life insurance agents and restaurant managers, to Problem Solving, which involves scientific investigation and technical applications such as biologists and foresters. The second dimension contrasts interest in structured working environments, such as medical record technicians and military enlisted personnel, with interest in more dynamic working environments, such as musicians and artists. The third dimension represents a range of interests from Social Service occupations, such as nurses and special education teachers, to occupations that involve Solitary Work, such as accountants and actuaries.

The pattern of BIS (Campbell et al., 1968) scores obtained for some clusters indicated potential areas for the development of new BISs for the Strong (Harmon et al., 1994). For example, while analyzing the profiles for the clusters, we noticed the need for BISs to measure interest in the areas of information technology and the social sciences. The results we obtained by comparing BIS profile shapes for male and female incumbent samples raises issues regarding the use of same-gender or combined-gender norms with interest measures. From a basic interest perspective, it would appear that interest profiles of men and women used in the occupations represented in the Strong Ring are very similar, given the mean profile correlation of .58, with the caveat that this model excluded a number of occupations that did not have similar male–female profiles. Although the use of combined-gender samples when using basic interest measures was generally supported, it should also be noted that these results may not generalize to the empirically keyed Occupational Scales of the Strong because of the heterogeneous content of the items combined in each different scale (see Hansen, 1984). The use of combined-gender samples allows for the integration of interest results with the U.S. Department of Labor's (2003) O*NET database because the information from that source is not separated by gender. The occupations in the 1994 edition of the Strong (Harmon et al., 1994) are generally limited to professional, technical, managerial, and skilled occupations; therefore, additional research is necessary to determine the extent to which the Strong Ring model can be generalized to other occupations in the O*NET.

Given the present prevalence of Holland's (1959, 1997) theory, the RIASEC hexagon is a natural comparison with the Strong Ring. An examination of the circular ordering of interest areas and occupational clusters in the first two dimensions of the Strong Ring offers an interpretation that parallels the circular ordering of the Holland types. Vector fitting results for the O*NET measures of Holland types provides additional connections between the two models, with the Persuasion Versus Problem-Solving dimension contrasting Enterprising with Realistic and Investigative interests, Structured Versus Dynamic linked primarily to level of Artistic interests, and Social Service Versus Solitary Work contrasting Social and Conventional interests. In the Strong Ring, a number of distinctions are made between areas of work that are somewhat obscured in Holland's system. For example, in the Strong Ring, medically related occupations tended to group together, whereas they are split into different Holland categories in the 1994 edition of the Strong (Harmon et al., 1994). The business area tended to group occupations from the Conventional and Enterprising areas, but other Enterprising occupations were grouped with some Artistic occupations in the influencing interest area. Although the Strong Ring provides a more multidimensional picture of the structure of occupations, this model clearly builds on the foundation of Holland's theory by using interests to assess person–environment fit in career counseling.

The results of this investigation provide several contributions to the field of vocational interest measurement and to the interpretation of the Strong (Harmon et al., 1994) and its use in the counseling setting. The combination of a hierarchical design, in which occupations can be discussed at different levels of abstraction, and a spatial representation, in which the interrelations between occupational clusters can be presented visually, provide a dynamic presentation of the Strong that may enhance its use in career counseling and other vocational applications. The results obtained when fitting a three-dimensional structure were a better fit for the data than a two-dimensional structure, which suggests that a two-dimensional RIASEC-based model may not be sufficient to represent the structure of the occupations in the Strong. The results of the spatial analysis provide new insight into the dimensions that underlie vocational interests and clarify vocational interest dimension issues that have been raised in prior investigations. More specifically, the People–Things dimension identified by Prediger (1982) is divided into two dimensions: Persuasive Versus Problem Solving and Social Service Versus Solitary Work. The potential to clarify a client's interests along the People–Things dimension may be useful in career counseling. Another comparison point to the Strong Ring is the three-dimensional spherical model proposed by Tracey and Rounds (1996; see also Tracey, 2002). In the spherical model, the first two dimensions correspond with Prediger's dimensions, and Prestige was identified as the third dimension. In the Strong Ring, prestige was not identified as the third dimension, which may reflect differences in the range of occupations used in the structural analyses in each study. Additional research is necessary to establish the incremental validity of the Strong Ring over alternative models of the world of work.

There are a number of potential opportunities for the application of the Strong Ring in career counseling. Because this model is based on the BIS of the Strong (Campbell et al., 1968), it is possible to match individuals to career options on the basis of the shape of their BIS profile. As noted by Donnay and Borgen (1996), basic interests are more effective for representing the multidimensional nature of interests. Therefore, using the Strong Ring as a model for matching individuals and work environments on the basis of assessment results obtained with the 25 Strong BISs is a potential improvement over the use of six Holland types. Also, the connections identified between the O*NET database and the Strong Ring provide a starting point for the development of an integrative strategy for presenting information to clients in career counseling on the basis of basic interest profiles. By linking the Strong Ring to the O*NET, clients have access to a comprehensive database of information on the occupations in the U.S. labor market, including worker attributes, organizational and work context, work content and outcomes, and trends in the labor market.

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Received August 25, 2003
Revision received January 16, 2004
Accepted January 23, 2004 ■