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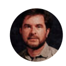

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Holland's RIASEC Model as an Integrative Framework for Individual Differences

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Using data from published sources, the authors investigated J. L. Holland's (1959, 1997) theory of interest types as an integrative framework for organizing individual differences variables that are used in counseling psychology. Holland's interest types were used to specify 2- and 3-dimensional interest structures. In Study 1, measures of individual characteristics and, in Study 2, measures of environmental demands were successfully integrated into a 2-dimensional circumplex interest structure using the technique of property vector fitting. In Study 3, cognitive abilities were successfully integrated into a 3-dimensional interest structure. Obtained results illustrate the potential utility of interest-based structures for integrating a wide range of information. This represents a 1st step toward the development of an Atlas of Individual Differences, mapping the interrelations among individual-differences measures to facilitate their integrative use in career counseling and other applied settings.

Keywords: Holland's RIASEC types, interests, personality, ability requirements, Atlas of Individual Differences

A recurrent theme in discussions of individual differences and person–environment interactions is the need for measurement across a wide range of psychological constructs (Ackerman, 1999; Borgen, 1999). For example, Lubinski (2000) advocated using measures of personality traits, interests, and abilities, noting "a much richer picture of humanity and psychological diversity is brought into focus when constellations of individual-differences variables are assembled for research and practice" (p. 407). Despite agreement on the need for integration, researchers have yet to agree upon a best strategy to achieve this goal. We propose using interest-based structures as the integrative framework, because an individual's interests represent a context-based synthesis of individual characteristics expressed as preferences for work activities and work environments. In the present study, a theoretical framework based on Holland's (1959, 1997) structure of interests was used to assemble constellations of individual differences variables, producing an integrated model of measures of individual characteristics and the characteristic demands placed on individuals in work environments that can be used in applied settings such as career counseling. Data from a number of published sources, measuring a diverse set of individual and environmental demands, were integrated into interest structures based on Holland's interest types.

Integration Within an Interest Model

A parallel to the question of integration by developing methods to represent connections across individual differences domains can be found in the history of map making. In the 16th century, the cartographer Gerardus Mercator created a unified picture of the geographic and political worlds when he published a series of maps as the first atlas (see Crane, 2002). Using the joint illustration of physical distances and political borders, Mercator recognized the integrative power of his atlas to "disclose how the two branches of study, those of geography and of political administration, can illuminate each other" (Mercator, as cited in Crane, 2002, p. 251). Mercator realized that a set of standard reference points is necessary to create a unified picture of different domains and would also facilitate the use of maps for navigation, which would promote commerce and various political applications.

Following the example of Mercator, we propose to create an integrated picture of the world of work through the joint illustration of individual differences domains. An important step in the development of this *Atlas of Individual Differences* is the identi-

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fication of a set of standard reference points. In the present study, Holland's (1997) interest types were put forward as a set of standard reference points to represent the structure of interests, thus creating a framework for integrating individual differences. Given its dominant position in the vocational interest literature (D. P. Campbell & Borgen, 1999; G. D. Gottfredson, 1999; Rounds & Day, 1999), Holland's structural model is the logical starting point for an investigation of the integrative utility of interests. Although studies on the connections between the RIASEC types and other individual differences variables have not explicitly investigated Holland's structural hypothesis, Ackerman and Heggestad's (1997) review of this research suggested that a structural investigation is warranted (see also Barrick, Mount, & Gupta, 2003; Larson, Rottinghaus, & Borgen, 2002). The current article can be viewed as an extension of Ackerman and Heggestad's work that integrates individual differences on a structural level by explicitly using two- and three-dimensional interest models based on Holland's theory.

Interests reflect preferences for certain behaviors and activities, the contexts in which these preferred activities occur, and also the outcomes associated with the preferred activities (Rounds, 1995). As such, interests emerge through the individual's experiences interacting with and adapting to the environment (e.g., Lykken, Bouchard, McGue, & Tellegen, 1993). Interests provide an organizational framework for describing educational, work, and leisure environments that can be used in career counseling and other applied settings. The effectiveness of interest-based measures for matching persons and environments is evidenced by their longstanding use in career counseling and other applied settings (ACT Inc., 1995; Clark, 1961; Dawis, 1992; Fryer, 1931).

The socioanalytic model of identity development (Hogan, 1983; Hogan & Roberts, 2000, 2004) hypothesizes that personality traits and abilities have an effect on the development of interests by influencing how individuals react to experiences and adapt to environments. The socioanalytic model also predicts that interests will have an effect on the development of personality and abilities because environmental preferences affect the range of experiences an individual has, thus influencing which traits are developed and refined over time (Roberts, Caspi, & Moffitt, 2003; Schooler, 2001). This developmental process continues throughout the life span, becoming more stable in adulthood due to both the effects of maturation and also increasing opportunities to self-select environments, especially learning and work environments (Ickes, Snyder, & Garcia, 1997; Scarr, 1996). Based on the socioanalytic model of identity development, we propose that abilities and personality traits will become embedded with interests over time and that these trait constellations will emerge in the context of work environments.

When people indicate preferences for educational, occupational, and leisure activities, they are choosing trait-relevant circumstances and opportunities to express their talents and personalities (Hogan & Roberts, 2000). Interest-based reference points provide a contextual framework for mapping the interrelations between individual differences domains, making our proposed integrative model different from other attempts to develop a common taxonomy (e.g., Gustafsson, 2001; Hofstee, 2001). Our idea of contextual convergence is similar to the idea of nomological clustering that Hough and colleagues (Hough, 1992; Hough, Eaton, Dunnette, Kamp, & McCloy, 1990; Hough & Schneider, 1996) used to develop a taxonomy of personality variables. Hough built a taxonomy with variables that have similar patterns of interrelations with other variables, using information provided by different types of individual differences variables to identify and validate distinct personality constructs. In comparison, our proposed model uses interests to represent the contextual nature of environments and to identify points of convergence across distinct sets of individual differences variables.

Holland's Theory of Interests

Holland's (1959, 1997) interest-based theory is organized with six personality types and six parallel environments: Realistic (R), Investigative (I), Artistic (A), Social (S), Enterprising (E), and Conventional (C)—referred to collectively as RIASEC. In the Holland model, the link between the individual's personality and the environmental context is direct: Personality is described in terms of preferences for work activities, and work environments are described in terms of the people who work there and the activities they perform. The RIASEC personality types are defined by both preferences and aversions that influence the choice of a work environment, and the environments are defined by typical work activities and other demands placed on individuals.

Although an integrative model based on Holland's (1959, 1997) model would primarily reflect work environments, to achieve successful work adjustment individuals must find a work environment that matches their personality traits, abilities, values, and other characteristics (Dawis & Lofquist, 1984). The individual's perceptions of which work environments will be a good match are often expressed through interests, and interest measures are an important cornerstone of many career counseling interventions. By linking personality and ability measures to work contexts through interests, an integrated model of individual differences would have important implications for models of person–environment fit and would be useful in applied settings such as career counseling.

Educational and work environments may be essential to understanding how personality traits and abilities are linked to interests, because it is environmental conditions that place demands on individuals, and these demands are clearly articulated in school and work settings (French, Caplan, & Harrison, 1982; Schooler, 2001). These demands create a context for relations between individual differences variables to emerge. In particular, the development of skills, which can be defined as task- or job-relevant clusters of declarative and procedural knowledge (Anderson, 1993; J. P. Campbell, McCloy, Oppler, & Sager, 1993), provides an example of the contextual convergence that is found in work environments. Individuals who prefer a given work environment, and who develop the skills necessary to function effectively in it, will share ability and personality characteristics with others who are in the same environment. Holland's types can be used to classify and describe work environments and to link individuals to environments using interests (see G. D. Gottfredson & Holland, 1996).

In Holland's (1959, 1997) theory, the six RIASEC types are arranged in a circular ordering, with distances between types inversely proportional to the degree of similarity between them (see Figure 1). Holland referred to this structure as a hexagon, although a number of researchers have noted that the underlying circular ordering and structure of the six RIASEC types is a

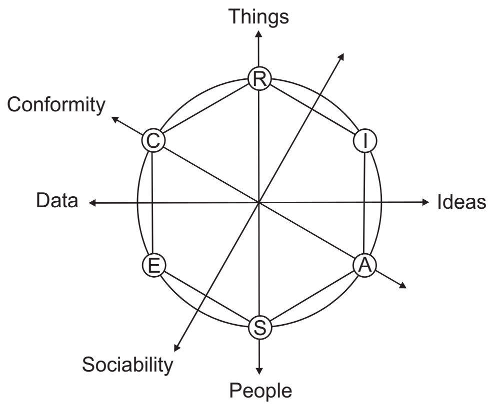

Figure 1. Holland's hexagon, a circumplex model of interest structure with dimensions proposed by Hogan (1983) and Prediger (1982).

circumplex (Hogan, 1983; Rounds, Tracey, & Hubert, 1992). Research has generally supported the circular ordering of the six RIASEC interest types and work environments in the United States (Rounds & Tracey, 1993; Tracey & Rounds, 1992). Therefore, Holland's taxonomy of interest types and parallel environments provide a set of empirically validated reference points for representing the circumplex structure of interests.

Personality, Interests, and Abilities

Holland stated that personality types and interest types are functionally equivalent (Holland, 1997, 1999), but personality and interests are generally considered to be distinct psychological constructs, albeit with some notable connections (Hogan & Blake, 1999; Savickas, 1999). In the area of personality research, the five-factor model (i.e., Openness to Experience, Conscientiousness, Extroversion, Agreeableness, and Neuroticism) has emerged as a dominant organizational framework for personality traits (Digman, 1990) and has become the focus of research linking personality with Holland's interest types. Recent meta-analyses (Barrick et al., 2003; Larson et al., 2002) have demonstrated relations between RIASEC interests and the five-factor model of personality (Costa & McCrae, 1992) that are consistent with Holland's conceptualization of his interest types. The two strongest associations between RIASEC and the five-factor model are between Extroversion and the S and E types, and between Openness to Experience and the A and I types (Ackerman & Heggestad, 1997; Hogan & Blake, 1999; Tokar, Fisher, & Subich, 1998). These associations have been found in college students (Tokar, Vaux, & Swanson, 1995), employed adults (Costa, McCrae, & Holland, 1984), and military trainees (G. D. Gottfredson, Jones, & Holland, 1993). Other RIASEC–five-factor associations have been identified between Agreeableness and the S type (Tokar et al., 1998) and Conscientiousness and the C type (G. D. Gottfredson et al., 1993). A negative correlation has been found between Neuroticism and the E type (De Fruyt & Mervielde, 1997).

Correlation-based research examining relations between RIASEC interests and measures of ability and intelligence have also produced results consistent with Holland's model. Ackerman and Heggestad (1997) provided a concise summary of studies in this area (i.e., Ackerman, Kanfer, & Goff, 1995; Kanfer, Ackerman, & Heggestad, 1996; Lowman, Williams, & Leeman, 1985; Randahl, 1991; Rolfhus & Ackerman, 1996). The results of these studies support a number of associations between RIASEC-based interest measures and ability measures, including math, spatial, and mechanical abilities linked with the I and R types; verbal and literary with the A type; and perceptual speed and numerical computation with the C type. Negative correlations have also been found between the E type and most ability measures, and between the S type and math/spatial abilities.

Two- and Three-Dimensional Interest Structures

An important limitation of research linking personality and abilities to the RIASEC types is that the focus in most studies has been on linear bivariate relationships. This methodology fails to capture the multidimensional nature of interest structure and may not effectively represent the interrelations between individual-differences domains. Results suggesting that E types are extraverted, A types are more open to new experiences, and so forth, may identify the strongest relationship between a RIASEC type and another measure, but they ignore the underlying structure of the Holland model. An analysis that explicitly tests Holland's structural model by accounting for the interrelations among the RIASEC types would produce a more nuanced and complete picture of the interrelations among individual-differences constructs in the context of work environments. Modeling the relative strength of associations in a circumplex or other structure makes it possible to identify robust and meaningful relations between distinct sets of individual differences variables that are only moderately correlated.

A frequently used method for representing a circumplex model is an orthogonal two-dimensional structure with coordinates that specify the relative positions of each type. For this reason, the RIASEC interest circumplex is often referred to as a two-dimensional model, and attempts have been made to attach psychologically meaningful labels to the dimensions. As illustrated in Figure 1, the most well-known dimensional interpretation is Prediger's (1982) model of Data–Ideas (contrasting E–C with I–A) and People–Things (contrasting S with R). Hogan (1983) proposed an alternative interpretation with a sociability dimension (contrasting S–E with R–I) and a conformity dimension (contrasting C with A). G. D. Gottfredson and Holland (1996) proposed a third dimension of Cognitive or Substantive Complexity to add to the two-dimensional interest circumplex. This dimension was identified in a factor analysis of the job analysis ratings of occupational characteristics found in the fourth edition of the *Dictionary of Occupational Titles* (*DOT*; U.S. Department of Labor, 1991). The cognitive complexity dimension is orthogonal to the two RIASEC interest dimensions: Individuals and environments may vary in cognitive abilities and demands, but the interrelations between interest types do not vary as a function of the level of cognitive complexity required for an occupation (Rounds & Day, 1999). In comparison to the two-dimensional RIASEC model, there have been few investigations of this proposed three-dimensional structure. For the present article, we developed a three-dimensional interest-based structure to compare with the RIASEC circumplex and conducted a limited number of analyses to evaluate its integrative potential.

Mapping Individual Differences Into the RIASEC Model

The linear multiple regression-based technique of property vector fitting (Jones & Koehly, 1993; Kruskal & Wish, 1978) is put forward here as a strategy for integrating individual-differences variables into Holland's model. This technique allows for the placement of a variable into a multidimensional space (i.e., the RIASEC interest structure) as a line, or *property vector*, emerging from the origin of the dimensional coordinate system. The angle of the property vector is calculated from the regression coefficients obtained by regressing variable scores for each RIASEC type on the structural coordinates representing the interest structure. Property vector fitting results illustrate the structural relations among interests and other individual-differences characteristics by indicating the orientation of characteristics in the interest structure and by comparing the relative orientations of different characteristics. Instead of focusing on the absolute magnitude of a particular bivariate relationship, this type of structural analysis systematically models the relative strength of associations between characteristics and the underlying interest structure.

To keep this investigation to a manageable size, personality measures were restricted to those associated with normal adjustment, ability measures were restricted to the ability requirements placed on individuals in work environments, and interests were represented by Holland's RIASEC model. Three sets of analyses were performed on data obtained from published sources to develop an integrated model of individual differences using two- and three-dimensional interest structures. In the first set of analyses, referred to as Study 1, we fitted individual characteristics into a two-dimensional interest-based RIASEC circumplex. In Study 2, we fitted measures of environmental demands into a two-dimensional interest-based RIASEC circumplex. In Study 3, we developed a three-dimensional RIASEC-based interest structure to integrate ability requirements not fitted successfully into the two-dimensional structure.

Study 1: Individual Characteristics

In the first study, measures of individual characteristics were fitted into a two-dimensional circumplex RIASEC interest structure. To demonstrate the integrative potential of this interest-based circumplex, we obtained data from published sources representing five different sets of measures: the NEO Personality Inventory (Costa & McCrae, 1992), the Myers-Briggs Type Indicator (MBTI; Myers & McCaulley, 1985), the 16-Personality Factor (16-PF) personality inventory (Cattell, Eber, & Tatsuoka, 1970), the Jackson Vocational Interest Survey (JVIS; Jackson, 1977), and the results of a set of measures of personal characteristics reported by Holland (1968). When we selected characteristics for inclusion in the analyses, the published data had to have been presented in a form suitable for our analyses. That is, the data had to provide a measure of the relations between the characteristic and the six RIASEC types, either as mean scores for each RIASEC type or as correlations between the characteristic and each type. The present data were selected to represent a diverse range of personal characteristics, although they do not represent an exhaustive survey of this domain. Instead, our investigation provides an initial look at the feasibility of an integrative structural approach, and the choice of data for this study was intended to illustrate the range of potential applications. If interests provide an effective framework for integration, then additional work will be necessary to incorporate other measures.

Method

Data Sources

Five-factor model of personality. Personality measures, such as the NEO Personality Inventory (Costa & McCrae, 1992), are often based on the five-factor model of personality (Digman, 1990) with dimensions of Neuroticism, Extraversion, Openness to Experience, Agreeableness, and Conscientiousness. In a meta-analysis of relations between these personality dimensions and the Holland types, Larson et al. (2002) compiled data from 12 studies that correlated a NEO Personality Inventory measure with a RIASEC-based interest measure. As reported by Larson et al., the total sample was 2,571 women and 2,358 men, with the sample sizes ranging from 85 to 645 for women and from 41 to 498 for men. Correlations between the five-factor model measures and the RIASEC scales were estimated for the entire sample, and separately for men and women. In the present study, the separate gender correlations were used.

MBTI. The MBTI (Myers, 1962; Myers & McCaulley, 1985) measures individuals' preferences on four basic dimensions of perception and judgment: Extraversion–Introversion, Sensing–Intuition, Thinking–Feeling, and Judging–Perceiving. MBTI scale data were obtained for the occupation groups listed in Myers and McCaulley (1985, p. 243). Myers and McCaulley created a type table for each occupation group ($N = 182$) that included the percentage of people in the occupation that lie on either end of the four bipolar dimensions. For example, the marketing personnel occupation group has 74.7% of the workers categorized on the Extraversion side and 25.3% on the Introversion side. We (Susan X Day and James Rounds) independently sorted 160 of the occupation groups into RIASEC categories after removing 22 occupation groups that did not clearly belong to a definable occupation (e.g., teaching assistants, college graduates) or that were aggregated across specialty (e.g., teachers, university teachers). These occupations were then classified according to their first-letter Holland code, with 16 classified as R, 19 as I, 10 as A, 41 as S, 21 as E, and 19 as C. Of the 160 occupations, 34 were not classified and not included in the analyses. Interrater agreement for these classifications was 79%. The percentage scores of the Extraversion, Sensing, Thinking, and Judging sides of the MBTI scales for each occupation were then aggregated by RIASEC type to create mean percentage scores for each Holland type on the four MBTI dimensions.

16-PF. The 16-PF provides scores on 16 factors designed to represent the domain of normal personality functioning (Cattell, 1973). These factors are Warmth, Intelligence, Stability, Dominance, Impulsivity, Conformity, Boldness, Sensitivity, Suspiciousness, Imagination, Shrewdness, Insecurity, Radicalism, Self-Sufficiency, Self-Discipline, and Tension. Bolton (1985) reported mean scores on all 16 factors for each of the six Holland types based on the scores for 69 occupational groups reported in the 16-PF manual (Cattell et al., 1970). Of the 69 occupational groups, 10 were classified by Bolton as R, 12 as I, 7 as A, 27 as S, 9 as E, and 4 as C. Also reported were the results for three composite or global factors: Anxiety, Extraversion, and Independence.

JVIS work styles. The JVIS (Jackson, 1977) includes eight work styles scales: Dominant Leadership, Job Security, Stamina, Accountability, Academic Achievement, Independence, Planfulness, and Interpersonal Confidence. As defined by Jackson, these scales reflect "a preference for working in a certain kind of environment, or working in a situation in which a certain mode of behavior is the norm" (p. 2). Thus, work styles represent preferences for different types of behavior an individual would prefer to perform in the workplace. The JVIS manual lists predicted standard scores for the work styles scales for men in 189 occupational samples. These samples were classified according to their first-letter Holland code using data summarized by D. P. Campbell (1971, pp. 464–469), excluding samples not representing a specific occupation (e.g., academically gifted graduates). This resulted in 164 occupational samples, with 27 classified as R, 42 as I, 25 as A, 26 as S, 23 as E, and 21 as C. Scores for each occupational sample were aggregated into RIASEC types to create measures of the relations between the six Holland types and the eight JVIS work styles scales.

College students' personal characteristics (CSPC). Holland (1968) explored the correlates of the Vocational Preference Inventory (Holland, 1965, 1985), the first RIASEC-based interest measure, in a sample of typical college students (5,369 men and 5,321 women). Participants of each gender were divided into six groups based on their Vocational Preference Inventory high-point code (the RIASEC scale they scored highest on), with 885 men and 31 women classified as R, 1,774 men and 554 women classified as I, 630 men and 1,284 women classified as A, 854 men and 3,033 women classified as S, 798 men and 148 women classified as E, and 428 men and 271 women classified as C. These groups were used to estimate mean scores for each RIASEC type on a series of personality scales: Originality, Dogmatism, Academic Type, Nonconformist Type, and Interpersonal Competency. Means for these personality characteristics for men and women for each of the six RIASEC types were obtained from Holland (1968, pp. 4–5).

Statistical Analysis

The statistical technique of property vector fitting (Jones & Koehly, 1993; Kruskal & Wish, 1978; Miller, Shepard, & Chang, 1964) was used to integrate personality characteristics into a two-dimensional RIASEC interest-based circumplex by locating a vector in the structure corresponding to each characteristic. The first step in the data analysis was to determine a set of coordinates to represent an interest structure by the location of the six RIASEC types in a two-dimensional circumplex. Coordinates representing the theoretical structure of Holland's circumplex model with equal distances between adjacent types were taken from Rounds and Tracey (1993): R (.00, .58), I (.50, .29), A (.50, –.29), S (.00, –.58) E (–.50, –.29), C (–.50, .29). Scores were then calculated for each measured characteristic, or *property*, that described the relations between the characteristic and each of the six RIASEC interest types.

A linear multiple regression procedure was used to regress scores for each property over the coordinates for two dimensions in the RIASEC circumplex. The salience of the property in terms of the RIASEC structure, an indication of how effectively the characteristic can be integrated into the interest structure, was assessed by the variance accounted for (R^2) in the multiple regression procedure, with higher values indicating a stronger systematic relationship. The results of the regression analyses were used to calculate directional cosines (regression coefficients standardized with the sum of their squared values equal to 1.00) for the vector's location in the interest structure. In the present study, vectors with R^2 values greater than .50 are illustrated as arrows emerging from the center of the RIASEC circumplex. Some researchers will vary the length of the property vector to indicate the strength of the association between the characteristic and the dimensional structure. In the present study, we found this technique to be ineffective due to the large number of characteristics successfully integrated into the RIASEC model. Therefore, we used equal-length vectors (see Armstrong, Smith, Donnay, & Rounds, 2004). When interpreting these results, it is important to remember that property vectors have bidirectional interpretations. That is, they can be interpreted both in terms of the direction they point toward, which indicates a strong positive relationship with that area of the interest circumplex, and also in the opposite direction, indicating a weak or negative relationship.

Results and Discussion

The results obtained from vector projection analyses of personality variables are presented in Table 1. Overall, 34 measures of individual characteristics were fit into the two-dimensional RIASEC interest-based circumplex with R^2 values greater than .50 (illustrated in Figure 2), 5 measures had R^2 values between .33 and .50, and 12 measures had R^2 values less than .33. In general, the interpretations of obtained results are consistent with previous research between RIASEC measures and measures of personality and are also consistent with Hogan's (1983) and Prediger's (1982) models. In particular, connections between the S and E types, with an emphasis on working with people and personality characteristics reflecting a preference for social contact, were supported. Proposed connections were also supported between the A type, with an emphasis on creative work, and personality characteristics related to openness; and between the C type, with an emphasis on structured work, and personality characteristics related to conformity. As compared with the regions of the interest circumplex representing these four types, there were comparatively few individual characteristics oriented in between the R and I types.

Five-Factor Model of Personality

The trait of Extraversion was associated primarily with the E type for men, and the vector for women pointed more toward the S type. The trait of Openness to Experience was associated with the A type, and Conscientiousness was associated with an area between the E and C types for both men and women. The orientations of the Extraversion, Openness to Experience, and Conscientiousness vectors are consistent with Holland's definitions of RIASEC types and with Hogan's (1983) sociability and conformity dimensions. Neuroticism was associated with the A type for men, but it did not reach the R^2 criteria of .50 for women. This result is somewhat surprising, because previous studies generally have not found strong associations between RIASEC and Neuroticism (see Ackerman & Heggestad, 1997; G. D. Gottfredson et al., 1993), although this connection may reveal some aspect of the creativity associated with the A type for men.

Table 1
Dimension Loadings and R^2 Values for Individual Characteristics

Measure	Dimension 1	Dimension 2	R^2
Five-factor Model			
Neuroticism—men	0.95	−0.31	.57
Neuroticism—women	0.77	0.64	.44
Extraversion—men	−0.72	−0.69	.91
Extraversion—women	−0.34	−0.94	.79
Openness—men	0.84	−0.54	.93
Openness—women	0.95	−0.31	.83
Agreeableness—men	0.87	−0.50	.13
Agreeableness—women	0.29	−0.96	.24
Conscientiousness—men	−0.99	0.13	.92
Conscientiousness—women	−1.00	−0.06	.58
Myers-Briggs Type Indicator			
Extraversion–Introversion	−0.55	−0.84	.90
Sensing–Intuition	−0.84	0.54	.86
Thinking–Feeling	0.07	1.00	.20
Judging–Perceiving	−1.00	0.06	.15
16-PF Personality Inventory			
Warmth (A)	−1.00	−0.08	.99
Intelligence (B)	0.98	−0.20	.46
Stability (C)	0.56	0.83	.22
Dominance (E)	0.95	−0.32	.79
Impulsivity (F)	−0.28	−0.96	.93
Conformity (G)	−0.99	0.15	.91
Boldness (H)	0.57	−0.82	.26
Sensitivity (I)	0.63	−0.73	.85
Suspiciousness (L)	0.33	−0.94	.21
Imagination (M)	0.74	−0.67	.55
Shrewdness (N)	−0.95	0.32	.73
Insecurity (O)	−0.44	−0.90	.12
Radicalism (Q_1)	0.90	−0.44	.33
Self-Sufficiency (Q_2)	1.00	0.08	.44
Self-Discipline (Q_3)	−0.28	0.96	.39
Tension (Q_4)	0.90	−0.43	.26
Independence (Function I)	0.83	−0.56	.72
Extroversion (Function II)	−0.55	−0.83	.74
Anxiety (Function III)	−0.78	−0.63	.02
Jackson work styles			
Dominant leadership	−0.67	0.74	.33
Job security	−0.46	0.89	.86
Stamina	0.77	0.64	.88
Accountability	−0.30	0.96	.75
Academic achievement	−0.81	−0.59	.59
Independence	−0.49	−0.87	.82
Planfulness	−0.98	−0.20	.90
Interpersonal confidence	−0.49	−0.87	.88
College students' personal characteristics			
Originality—men	0.91	−0.42	.90
Originality—women	0.95	−0.32	.89
Academic type—men	0.92	−0.40	.87
Academic type—women	0.97	−0.25	.87
Dogmatism—men	−0.46	0.89	.84
Dogmatism—women	−1.00	−0.09	.85
Nonconformist type—men	0.74	−0.68	.52
Nonconformist type—women	0.88	0.48	.17
Interpersonal—men	−0.09	−1.00	.90
Interpersonal—women	0.07	−1.00	.98

MBTI and 16-PF

The MBTI and 16-PF measures of Extraversion fit into a region of the circumplex between S and E, similar to the results for the five-factor-model-based measure of Extraversion, and consistent with the people orientation of these types and Hogan's (1983) sociability dimension. The 16-PF measure of Impulsivity also pointed toward the S and E types. The MBTI measure of Sensing and the 16-PF measures of Shrewdness and Conformity pointed toward the C region of the circumplex; and the 16-PF measures of Independence, Imagination, and Sensitivity pointed toward A. These results are consistent with Hogan's conformity dimension, because characteristics consistent with conformity point toward C, and characteristics associated with Openness point in the opposite direction toward A. Additional results linking the 16-PF with the RIASEC circumplex included measures of Warmth (oriented between E and C), Impulsivity (oriented between S and E), and Dominance (oriented toward A).

JVIS and CSPC

The JVIS measure of Stamina was oriented toward the I type. Several vectors were oriented toward the A, S, E, and C types, which offer interpretations consistent with Hogan's model. The CSPC measures of Academic type (for both men and women), Originality (for both men and women), and Nonconformist type (men only) were oriented toward the A type. The CSPC measure of Interpersonal Confidence (for both men and women) was oriented toward the S type. The JVIS measures of Independence and Interpersonal Confidence were oriented between the S and E types. The JVIS measure of Planfulness and the CSPC measure of Dogmatism (women only) were oriented between E and C. Additionally, results were obtained linking the JVIS measures of Academic Achievement (oriented toward E), Accountability (oriented between C and R), Job Security (oriented between C and R), and the CSPC measure of Dogmatism (for men, oriented between C and R) to the RIASEC circumplex.

Individual Characteristics Not Effectively Integrated

Although a large number of vectors were successfully fitted, a number of other characteristics were not effectively represented in the interest circumplex. The interpretation of these results is somewhat ambiguous, as there are several possible explanations for why a characteristic may not have been successfully integrated into the RIASEC circumplex. First, there may have been issues related to sampling or measurement error in the data used for this study. Second, the characteristic simply may not have varied substantially across the six RIASEC types (i.e., the characteristic may be equally important, or equally irrelevant, to individuals working across a wide range of environments). Finally, these results may reflect a fundamental limitation of using the six RIASEC types to represent interest structure, or of using a two-dimensional interest structure as an integrative framework.

The measure of Agreeableness was not effectively integrated for either the male or female samples. An examination of the Larson et al. (2002) data reveals that the pattern of interrelations for Agreeableness is incompatible with the interest circumplex, because the strongest positive association is with the S type, and the strongest negative association is with the E type. The poor fit of the MBTI Thinking–Feeling vector is consistent with the Agreeableness results, and this is consistent with previous research linking these scales (McCrae & Costa, 1989). The 16-PF Anxiety measure and its primary scales (Stability, Suspiciousness, Insecurity, and

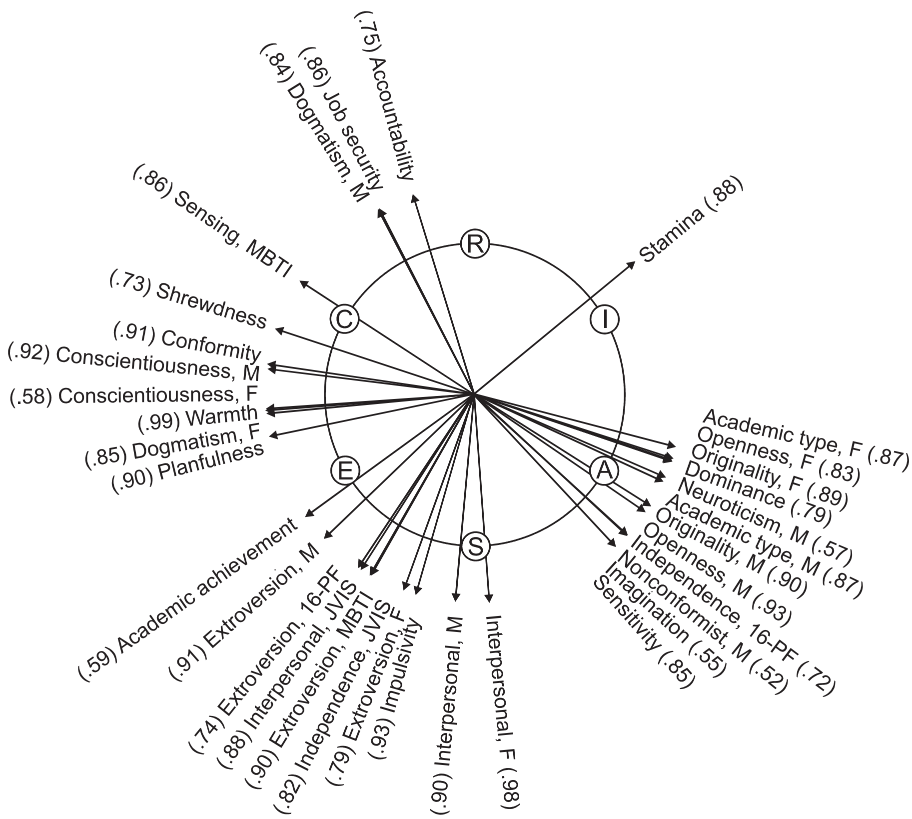

Figure 2. Individual characteristics integrated into a two-dimensional RIASEC interest circumplex. R^2 values from property vector fitting analyses appear in parentheses. M = male; MBTI = Myers-Briggs Type Indicator; F = female; 16-PF = 16-PF personality inventory; JVIS = Jackson Vocational Interest Survey.

Tension) accounted for a very small amount of variance. In contrast, the Neuroticism measure for men was embedded, suggesting that a more narrowly focused measure made a difference in the fit. The 16-PF measures of Intelligence, Boldness, Radicalism, Self-Sufficiency, and Self-Discipline were fit with R^2 values between .33 and .50, suggesting that although the current results did not meet the statistical cutoff for integration, additional research may help improve researchers' understanding of the relations between 16-PF measures and interest-based models of the world of work.

Study 2: Environmental Demands

Having found support for the integrative potential of an interest-based two-dimensional circumplex with measures of individual characteristics, we now focus on the environmental side of the equation. The environmental demands placed on individuals in working environments are used to provide a pragmatic index of individual differences in ability requirements. The integrated model of individual differences characteristics being developed in this article is inherently contextual, because it synthesizes a range of characteristics used by individuals as they function in environments. This conceptualization of individual differences in ability being measured by environmental demands in work is important, because an inevitable determinant of a successful person–environment fit will be the match between the abilities the individual possesses and the abilities necessary for success in a work environment (e.g., Dawis & Lofquist, 1984).

Work environments often have clearly defined sets of ability requirements that are necessary for successful functioning. Using Holland's types as a common set of reference points allows for the integration of results from the environmental demands with the results from the individual characteristics obtained in Study 1. To represent the environmental demands placed on individuals, we used characteristics taken from G. D. Gottfredson and Holland (1996) and L. S. Gottfredson (1980), who reported data from comprehensive surveys of work environments performed by the U.S. Department of Labor. We also used data from the U.S. Department of Labor presented in the recently developed O*NET database (U.S. Department of Labor, 1998).

Method

Data Sources

Dictionary of Holland Occupational Codes (DHOC). The *DHOC* (G. D. Gottfredson & Holland, 1996) provides a comprehensive list of the Holland type for each occupation identified by the U.S. Department of Labor. Mean scores for each RIASEC type on a number of worker aptitude ratings are provided: intelligence, verbal aptitude, numerical aptitude, spatial aptitude, form perception, clerical perception, motor coordination, finger dexterity, manual dexterity, eye-hand-foot coordination, and color discrimination. In the present analysis, data were used for occupations in the higher prestige occupations of General Educational Levels 5–6, representing 94 R occupations, 340 I occupations, 102 A occupations, 227 S occupations, 327 E occupations, and 18 C occupations. The decision to use the higher level data from this source was intended to contrast with the use of middle-prestige occupation data from the L. S. Gottfredson (1980) study.

The DOT. The *DOT* (U.S. Department of Labor, 1965) characterizes job titles according to work activities, job requirements, and worker traits. L. S. Gottfredson (1980) derived mean scores of six of these characterizations for each Holland job type: involvement with data, things, and people; educational level; specific vocational preparation; and self-direction. The results presented by Gottfredson divided occupations into low, high, and moderate prestige levels. In the present analyses, the information for the 146 middle-prestige occupations was used due to the small number of I and A occupations in the low-prestige groups and the small number of R and C occupations in the high-prestige groups. As originally reported in L. S. Gottfredson (1978), 41 of the middle-prestige occupations were classified as R, 10 as I, 10 as A, 24 as S, 48 as E, and 13 as C.

*O*NET ability requirements.* For the U.S. Department of Labor's (1998) O*NET database, a comprehensive taxonomy was developed of 52 cognitive, psychomotor, physical, and sensory–perceptual abilities required to perform different jobs effectively (Fleishman, Costanza, & Marshall-Mies, 1999). We focused our analyses on the intellectual (cognitive) abilities identified by Ackerman and Heggestad (1997). These included verbal abilities (oral comprehension, written comprehension, oral expression, written expression), fluency of ideas and originality, quantitative abilities (mathematical reasoning, number facility), perceptual abilities (speed of closure, flexibility of closure, perceptual speed), and spatial abilities (spatial orientation and visualization). The U.S. Department of Labor recently replaced the *DOT* with a new system designed to minimize redundancy by replacing individual job titles with a set of 1,077 occupational units. Ability requirement scores were obtained for the occupational units in the O*NET database. Mean scores for each RIASEC type on each of these 13 characteristics were calculated by grouping occupations using Holland high-point codes obtained from the O*NET database. Of the 1,122 occupational units, 596 were classified as R, 123 as I, 58 as A, 100 as S, 134 as E, and 111 as C.

*O*NET occupational reinforcers.* Occupational reinforcers measure the work-related values being reinforced in a given occupation. The 21 occupational reinforcers in O*NET were modified from the 21 occupational reinforcer scales found in the Minnesota Job Description Questionnaire (Borgen, Weiss, Tinsley, Dawis, & Lofquist, 1968; McCloy et al., 1998). We limited the analysis to those occupational reinforcers that were judged to be most descriptive of the RIASEC types. Jason P. McVay and James Rounds reviewed Holland's (1997) type descriptions and two empirical articles that linked the 21 reinforcers to the RIASEC types (Rounds, Shubsachs, Dawis, & Lofquist, 1978; Toenjes & Borgen, 1974) and then independently selected reinforcers to use in the present study. We agreed on 12 of 13 reinforcers and after discussion selected 13 of the 21 reinforcers: Ability Utilization, Achievement, Activity, Authority, Company Policies, Coworkers, Creativity, Independence, Moral Values, Security, Supervision—Human Resources, Supervision—Technical, and Variety. Mean scores for each RIASEC type were obtained using the same strategy for obtaining ability requirement scores (i.e., reinforcer scores for all 1,077 occupational units grouped by Holland code to create mean reinforcer scores for each RIASEC type).

Statistical Analyses

The statistical technique of property vector fitting was used to integrate environmental demands into the interest-based circumplex using the same regression procedures outlined in Study 1 and the same criteria of R^2 greater than .50 for inclusion in the integrated model.

Results and Discussion

The results obtained from vector projection analyses of environmental demands are presented in Table 2. A total of 31 environmental measures were fitted into the interest-based circumplex with R^2 values greater than .50 (see Figure 3), 2 measures had R^2 values between .33 and .50, and 10 measures had R^2 values less than .33. In general, the pattern of obtained results with environmental demands offers interpretations consistent with the results obtained with personality characteristics in Study 1. The recurrent patterns seen across the two studies suggest that important connections between personality, interests, and ability requirements can be identified when these individual differences domains are integrated in a circumplex structure. An interesting difference in the results of the two studies was the large number of environmental demands that were integrated in the region of the interest circumplex in between the R and I types in Study 2, as compared with the small number of individual characteristics integrated in this region of the circumplex in Study 1.

The DHOC and DOT

The measure of involvement with things was oriented toward the R type, and the involvement with people measure was oriented toward the E type. These results are consistent with the People–Things dimension in Prediger's (1982) model and with Hogan's (1983) sociability dimension. The measures of involvement with data and clerical skills pointed in the expected direction toward the C region of the interest circumplex. Color discrimination and general intelligence were also integrated, with an orientation between I and A. *DOT* measures of specific vocational preparation and general educational level were oriented toward the A type, and the measure of self-direction was oriented toward the S type.

Many of the property vectors integrating environmental characteristics from the *DHOC* and *DOT* into the RIASEC circumplex were oriented toward the region of the circumplex associated with R and I. It is interesting to note both that this area is not represented very effectively by the individual characteristics integrated in Study 1, and that the number of ability requirements associated with working with people is limited. Vectors in the R and I region of the circumplex include numerical aptitude, eye-hand-foot coordination, spatial aptitude, form perception, motor coordination, manual dexterity, and finger dexterity. Aside from numerical aptitude, these measures of ability describe skills associated with

Table 2
Dimension Loadings and R^2 Values for Environmental Demands

Measure	Dimension 1	Dimension 2	R^2
DHOC characteristics			
Intelligence	1.00	0.02	.68
Verbal aptitude	0.97	−0.26	.25
Numerical aptitude	−0.07	0.99	.59
Spatial aptitude	0.56	0.83	.97
Form perception	0.73	0.68	.95
Clerical perception	−0.90	0.44	.55
Motor coordination	0.79	0.61	.96
Finger dexterity	0.86	0.52	.98
Manual dexterity	0.75	0.66	.98
Eye-hand-foot coordination	0.28	0.96	.92
Color discrimination	0.94	0.34	.94
DOT characteristics			
Involvement with data	−0.66	0.75	.56
Involvement with things	−0.17	0.99	.74
Involvement with people	−0.69	−0.73	.78
Specific vocational preparation	0.83	−0.56	.70
Self-direction	0.34	−0.94	.62
General educational level	0.79	−0.62	.60
O*NET ability requirements			
Oral comprehension	0.44	−0.90	.31
Written comprehension	0.67	−0.75	.14
Oral expression	0.24	−0.97	.37
Written expression	0.62	−0.78	.16
Fluency of ideas	0.76	−0.66	.61
Originality	0.79	−0.61	.72
Mathematical reasoning	−0.59	0.81	.01
Number facility	−0.78	0.63	.06
Speed of closure	0.98	−0.19	.28
Flexibility of closure	0.96	0.30	.57
Perceptual speed	0.04	1.00	.39
Spatial organization	0.60	−0.80	.05
Visualization	0.99	0.15	.56
O*NET work reinforcers			
Ability Utilization	0.88	−0.48	.72
Achievement	0.78	−0.62	.83
Activity	−0.96	0.28	.16
Authority	0.07	−1.00	.57
Company Policies	−0.98	0.22	.80
Coworkers	−0.13	−0.99	.70
Creativity	0.82	−0.57	.75
Independence	0.34	0.94	.74
Moral Values	0.35	0.94	.50
Security	−0.33	−0.94	.00
Supervision—Human Relations	−0.93	0.36	.72
Supervision—Technical	−0.89	0.46	.85
Variety	0.62	−0.78	.72

Note. DHOC = Dictionary of Holland Occupational Codes; DOT = Dictionary of Occupational Titles.

manipulating objects, as well as performing physical and mechanical activities. In comparison, people-oriented work environments emphasize social skills, and perhaps this area is underrepresented because these skills are thought of as personality characteristics instead of as skills.

*O*NET Work Characteristics*

The occupational reinforcers Moral Values and Independence were oriented toward the R type. The ability requirements of flexibility of closure and visualization were oriented toward the I type. The ability requirement of fluency of ideas and the occupational reinforcers Ability Utilization, Creativity, Originality, Achievement, and Variety were oriented toward the A type. The occupational reinforcers Authority and Coworkers pointed toward the S type. The occupational reinforcer Company Policies and the two supervision reinforcers were oriented toward the C type. The property vectors representing ability requirements and work reinforcers offer interpretations that are similar to those of the individual characteristics integrated in Study 1. For example, the reinforcers oriented toward the C type reflect a more structured work environment, whereas the reinforcers and ability requirements oriented toward the A type reflect a more open work environment.

Environmental Demands Not Effectively Integrated

As was the case in Study 1, a number of characteristics did not reach the statistical criterion of an R^2 greater than .50. These results provide insight into the limitations of using a circumplex model to integrate personality, interests, and abilities. In particular, measures related to verbal ability were not a good fit in the circumplex model; these measures included the *DHOC* measure of verbal ability and O*NET measures of oral comprehension, written comprehension, oral expression, and written expression. The O*NET ability requirements of mathematical reasoning, number facility, speed of closure, perceptual speed, and spatial orientation—and the occupational reinforcers of Activity, Moral Values, and Security—were also not well represented. The finding that ability requirements that represent level of complexity, especially the O*NET measures of verbal and mathematical ability, were not successfully integrated does provide some support for developing a three-dimensional alternative to the RIASEC circumplex. As was the case with Study 1, however, the interpretation of these results is somewhat ambiguous due to the potential for sampling or measurement error and to the limitations of using the six RIASEC types to represent interest structure.

Study 3: Three-Dimensional Interest Model

The primary objective of the third study was to investigate the potential integrative utility of a three-dimensional interest model. As previously discussed, a number of three-dimensional interest models have been proposed, including G. D. Gottfredson and Holland's (1996) RIASEC-based model with a third dimension of complexity. It is proposed that a third dimension of cognitive complexity could account for the measures of verbal ability and other ability requirements not integrated in the two-dimensional circumplex model in Study 2. To evaluate this hypothesis, we developed a three-dimensional interest model using occupations from Holland's Vocational Preference Inventory and data from the O*NET database. The O*NET ability requirements and occupational reinforcers used in Study 2 were then integrated into this three-dimensional model using property vector fitting.

Method

Data Sources

Occupations. Holland (1965, 1985) developed the Vocational Preference Inventory to measure interests using 90 occupational titles (items), with 15 occupational titles representing each of the

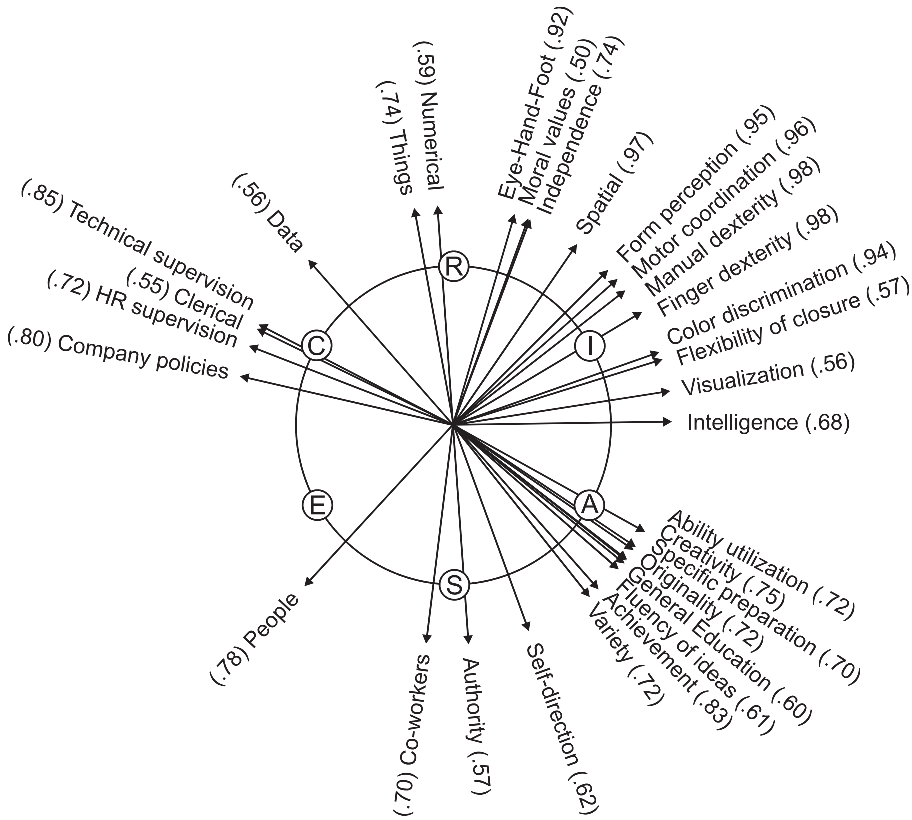

Figure 3. Environmental demands integrated into a two-dimensional RIASEC interest circumplex. R^2 values from property vector fitting analyses appear in parentheses. HR = human resources.

six RIASEC types. These occupations were selected because of their well-documented association with Holland's model. Using the Vocational Preference Inventory occupational titles, we matched 68 of the 90 occupations with occupational titles in the O*NET database of 1,077 occupations. The match yielded 14 R occupations (e.g., electricians, commercial helicopter pilots), 11 I occupations (e.g., anthropologists, botanists), 13 A occupations (e.g., cartoonists and animators, columnists and commentators), 7 S occupations (e.g., counseling psychologists, teachers), 12 E occupations (e.g., business managers, real estate agents), and 11 C occupations (e.g., accountants, budget analysts). Each occupation in the O*NET has a RIASEC interest profile. The 68 interest profiles were correlated, producing a 68 $\times$ 68 occupation correlation matrix. This correlation matrix was submitted to a multidimensional scaling analysis to produce a spatial model. When the interest profiles of these occupations are scaled, the first two dimensions should produce a RIASEC circumplex structure. However, it is the characteristics of the third dimension that are the focus of the present investigation. In particular, it is predicted that O*NET ability requirements not successfully integrated into a two-dimensional RIASEC circumplex will fit into the third dimension.

Ability requirements and occupational reinforcers. The 13 ability requirements and 13 occupational reinforcers from Study 2 were used in the Study 3 analyses. Scores on each of these environmental demands for each of the 68 occupations were obtained from the O*NET database and used in regression analyses. Consistent with Studies 1 and 2, a statistical criterion of R^2 greater than .50, indicating that 50% of the variance in the property was explained by location in the three-dimensional interest structure, was used for evaluating results obtained in regression analyses.

Results and Discussion

Development of Three-Dimensional Model

The three-dimensional occupational model was based on the multidimensional scaling of 68 O*NET occupations. We examined two-, three-, and four-dimensional solutions. The stress values and variance accounted for (in parentheses) were .16 (86.7%) for the two-dimensional solution, .08 (95.9%) for the three-dimensional solution, and .04 (98.9%) for the four-dimensional solution. On the basis of these results, the three-dimensional solution appeared to provide a reasonable fit to the data (Fitzgerald & Hubert, 1987). Additionally, the 9.2% increase in variance accounted for when moving from two to three dimensions is consistent with other studies investigating the third dimension of interests (Deng, Armstrong, & Rounds, 2007; Einarsdottir & Rounds, 2000; Mount, Barrick, Scullen, & Rounds, 2005; Tracey, 2002; Tracey & Rounds, 1996). We selected the three-dimensional solution to evaluate G. D. Gottfredson and Holland's (1996) hypothesis that cognitive demands will load on the third dimension in a RIASEC-based interest structure. Figure 4 shows the results obtained for Dimensions I and II, and Figure 5 shows Dimensions I and III. For presentation purposes, we plotted some representative occupations of the 68, along with the mean location of the RIASEC environments based on the scale values of the high-point code of the 68 occupations. Holland's RIASEC circular order model is clearly evident in Figure 4.

Ability Requirements

Property vector fitting results for ability requirements integrated into the three-dimensional interest structure are presented in Table 3. As illustrated in Figure 5, four ability requirements with low R^2 values in Study 2 were plotted: written comprehension (ΔR^2 from .14 to .50), written expression (ΔR^2 from .16 to .59), mathematical reasoning (ΔR^2 from .01 to .51), and number facility (ΔR^2 from .06 to .62). Consistent with the results of Study 2, none of these cognitive ability requirements had their highest loadings on the two dimensions representing Holland's circular order model. As shown in Figure 5, these four cognitive ability requirements were oriented toward Dimension III, consistent with a third dimension of complexity. The vectors for the two verbal ability requirements were located almost entirely along Dimension III, and the two quantitative ability requirement vectors were located between Dimension I and Dimension III. Written comprehension, written expression, and mathematical reasoning pointed toward I occupations, and number facility pointed toward C occupations.

Occupational Reinforcers

Property vector fitting results for occupational reinforcers integrated into the three-dimensional interest structure are presented in Table 3. As illustrated in Figure 4, 6 of the 13 occupational reinforcer vectors fit into the three-dimensional interest structure with R^2 values greater than .50. Five of these six characteristics (Ability Utilization, Achievement, Creativity, Moral Values, and Supervision—Technical) were previously integrated into the two-dimensional RIASEC model in Study 2. The interpretation of the property vectors for these five characteristics is similar across the two interest structures. As with the two-dimensional model, the high ends of the Ability Utilization, Achievement, and Creativity vectors were located near the A occupations, and the Supervision—Technical vector pointed in the opposite direction. The Moral Values vector separated I occupations on the high end and E occupations on the low end. The results for the Security reinforcer are included in Figure 5, because its property vector correlated highest with the third dimension.

One caveat to the results obtained with the three-dimensional model concerns the change in R^2 values for measures that were successfully integrated into the two-dimensional circumplex. Al-

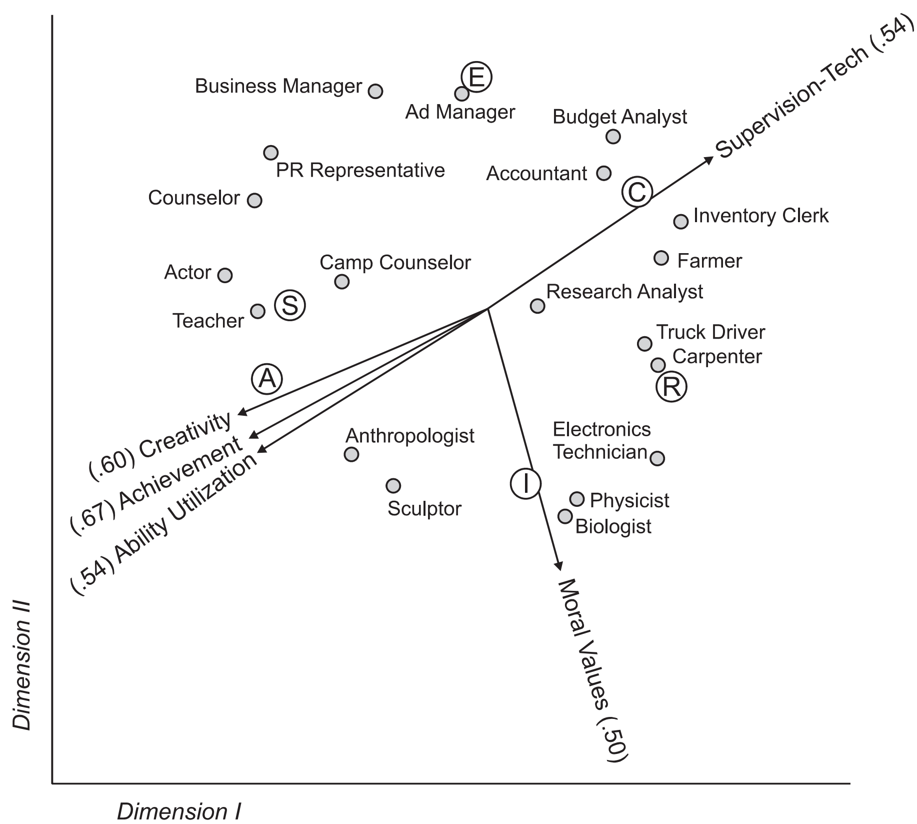

Figure 4. O*NET ability requirements and occupational reinforcers integrated into a three-dimensional RIASEC interest structure, Dimensions I and II. R^2 values from property vector fitting analyses appear in parentheses. PR = public relations; Tech = technical.

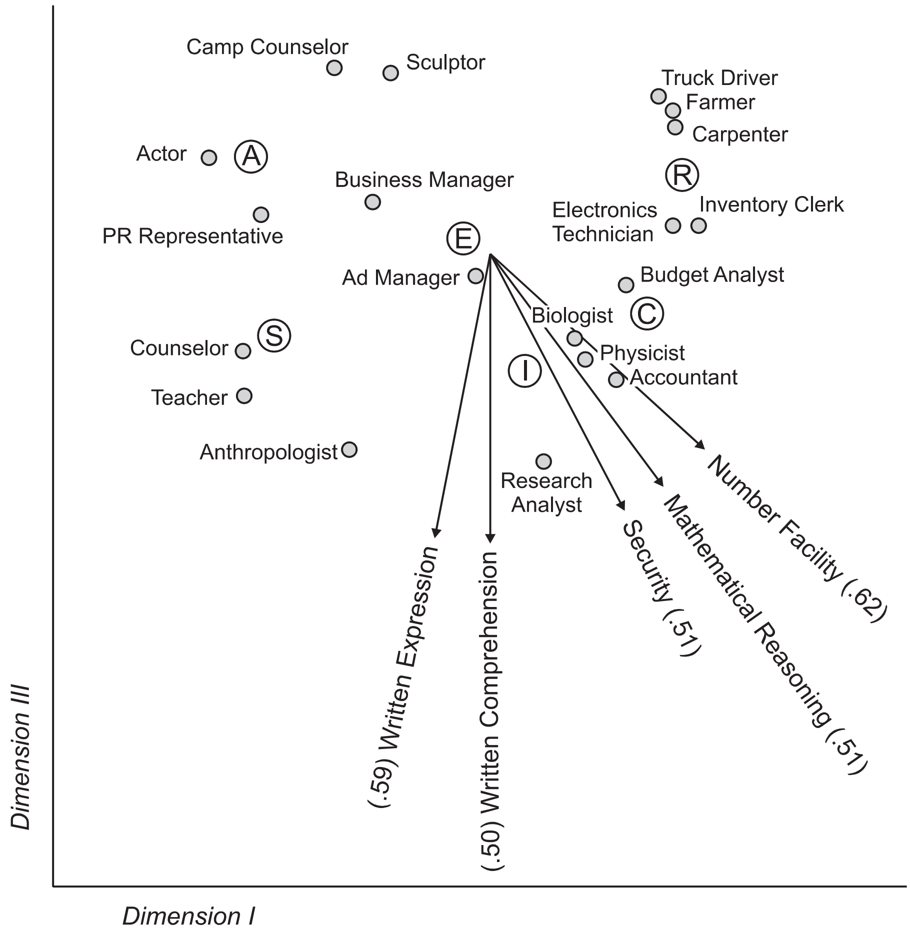

Figure 5. O*NET ability requirements and occupational reinforcers integrated into a three-dimensional RIASEC interest structure, Dimensions I and III. R^2 values from property vector fitting analyses appear in parentheses. PR = public relations.

though the fit of verbal and mathematical ability requirements associated with a complexity dimension were improved, the fit of a number of other O*NET measures decreased. These results may reflect the idiosyncrasies of the data used to evaluate the three-dimensional model. The range of data available for investigating a three-dimensional model was limited compared with the data available for the two-dimensional model, which increases the tentativeness of our results. Nevertheless, the results of the three-dimensional model are important because they provide independent support for a cognitive complexity dimension in an interest structure. Also, it should be noted that there have been other interpretations put forward for the third dimension of interests, such as prestige (see Tracey & Rounds, 1996). The present results in support of cognitive complexity being a component of the third dimension of interests do not contradict the prestige interpretation of this dimension, however, because prestige and cognitive demands are positively correlated in the workplace (Blishen, Carroll, & Moore, 1987). Additional work is necessary to clarify researchers' understanding of how this complexity dimension is related to other prestige and other potential interpretations of the third dimension.

General Discussion

The results obtained in the present study support the use of interest structures as a framework to create an integrated model of individual differences. Environmental demands and ability requirements align with personality characteristics, suggesting that individuals combine preferences with their abilities and personality traits to produce an integrated and adaptive adjustment to environmental contexts. In short, our results support the hypothesis that interests, due to their contextual nature, can provide a starting point for combining a wide range of individual differences variables to produce a cohesive, multifaceted taxonomy, an atlas of individual differences.

The proposed atlas has a number of potential counseling and research implications. In particular, when working in counseling and other applied settings, it is important to be able to link relevant occupational information to individuals' career choices (McDaniel & Snell, 1999), and the integrative nature of the current results may facilitate the process of matching individuals to career choices using a wide range of individual differences characteristics in a coherent manner. Using the RIASEC framework for integrating

Table 3
*Three-Dimensional Model Dimension Loadings and R^2 Values for O*NET Work Reinforcers and Ability Requirements*

Measure	Dimension 1	Dimension 2	Dimension 3	R^2
O*NET ability requirements				
Oral comprehension	−0.21	0.06	−0.64	.45
Written comprehension	0.00	−0.04	−0.70	.50
Oral expression	−0.18	0.21	−0.59	.43
Written expression	−0.15	0.00	−0.75	.59
Fluency of ideas	−0.49	−0.06	−0.18	.27
Originality	−0.58	−0.18	0.09	.38
Mathematical reasoning	0.39	0.28	−0.53	.51
Number facility	0.51	0.38	−0.46	.62
Speed of closure	0.23	−0.17	−0.46	.29
Flexibility of closure	0.26	−0.49	−0.12	.32
Perceptual speed	0.48	−0.05	0.06	.23
Spatial organization	0.35	−0.02	0.46	.33
Visualization	0.18	−0.31	0.46	.34
O*NET work reinforcers				
Ability Utilization	−0.61	−0.38	−0.11	.54
Coworkers	0.06	0.51	−0.29	.35
Independence	−0.72	−0.51	0.12	.27
Achievement	0.29	−0.39	−0.07	.67
Activity	−0.08	0.38	−0.45	.43
Authority	0.42	0.44	−0.37	.33
Company Policies	−0.71	0.27	−0.30	.34
Creativity	−0.71	−0.32	−0.03	.60
Moral Values	0.17	−0.60	0.33	.50
Security	0.33	−0.02	−0.63	.51
Supervision—Human Relations	0.42	0.38	−0.13	.34
Supervision—Technical	0.61	0.41	0.07	.54
Variety	−0.59	0.03	−0.13	.36

information from multiple sources simplifies the process of presenting information to clients. Additionally, the visual–spatial presentation of interests in Holland's model enhances the counseling process (Rayman & Atanasoff, 1999), and the current research using property vector fitting has the potential to capitalize on this advantage of the Holland model by providing a visual map of an integrated domain of individual differences. Conversely, the present findings also demonstrate the limitations of using Holland's model, because not all individual-differences characteristics that may be important to the career choice and development process were successfully integrated into the RIASEC-based circumplex. Therefore, additional research is needed to develop alternative integrative models for use in counseling and other applied settings.

Additionally, it should be noted that the present findings describe typical patterns of association between measures using data obtained from large samples and databases primarily representing the majority group of Caucasians in the United States. Individual differences in adherence to the RIASEC model (i.e., the extent to which individuals perceive the world of work in a Holland-consistent manner; see Tracey & Darcy, 2002) may affect the utility of the atlas when working with clients. Cross-cultural differences in perceptions of the world of work may also affect the utility of the atlas when working with clients from diverse backgrounds. Therefore, additional research is needed to examine how individual and cross-cultural differences in perceptions of the world of work and adherence to the RIASEC model moderate the associations between interests, personality, and ability requirements illustrated here.

Interests as an Integrative Framework

The present results support Ackerman and Heggestad's (1997) use of Holland's interest model to anchor individual-differences variables. The dimensional models proposed by Hogan (1983) and Prediger (1982) are logical comparison points for the integrative framework produced by our vector projection analyses. Rounds and Tracey (1993), however, demonstrated that these two models are functionally equivalent, which suggests that multiple dimensions may be present in Holland's circumplex. Rather than trying to identify a minimum number of dimensions, the present analyses were designed with the goal of integrating a wide range of information into the circumplex structure. Perhaps the most striking effect of fitting a diverse range of characteristics is the fanlike arcs of the circumplex covered by different sets of characteristics. Although our results do not contradict Hogan's or Prediger's dimensional models, they arguably provide a richer picture of individual differences, and it is the recurrent themes that emerge across domains that are the critical findings.

The use of vector projection to develop an inclusive integrated model may be questionable to those who prefer the traditional methods for developing spatial representations of psychological phenomena that produce a simple structure with orthogonal dimensions. Although the integrative model outlined here is not as parsimonious as a simple structure alternative, the multifaceted picture created by our results may offset the loss of economy. Returning to the atlas analogy, a map of the United States that includes only major interstate highways would describe the most simple and direct paths between major cities but would overlook many potentially important (and often more scenic) roadways. Furthermore, our results complement previous research on simple structures in the various individual-differences domains by demonstrating how information from each area converges in an environmental context modeled by an interest structure. It is also worth noting that recent reviews of the substantial literature on simple structure methods have often concluded with a discussion of the need for different perspectives and more inclusive approaches (see Lubinski, 2000).

Despite the substantial empirical support for the structure of Holland's model, there is some evidence to suggest that the six RIASEC types are not sufficient to represent the complexity of the world of work. The types are very broad; have been found to be multidimensional; and combine areas of work, such as the factory and outdoor occupations in the R type, that have notable differences (Einarsdottir, 2001). As outlined in Rounds (1995), the most comprehensive factor analytic studies of interest structure tend to identify more than six factors. The use of a more comprehensive model of interest structure may allow for the integration of information from a wider range of individual-differences variables. Although there are measures available, such as basic interests (Rounds & Day, 1999), that could be used to create more sophisticated and representative interest structures, to date there has been little systematic effort directed toward the development of spatial models of basic interest structure.

One limitation of the present study is the potential difficulty in interpreting results for characteristics that were integrated into the RIASEC circumplex but with orientations that do not fit with Holland's (1997) theory. Examples of this include finding Dominance oriented toward A, Authority oriented toward S, Academic Achievement oriented toward E, Warmth oriented between E and C, and Shrewdness oriented toward C. In comparison, Extraversion measures fit well into the Holland model because the strongest associations are with E and S, the weakest/most negative associations are with the R and I types at the opposite side of the circumplex, and the resulting angle of the property vector is consistent with researchers' understanding of the RIASEC types. When a property vector is not aligned in the expected orientation, then the relationship between the characteristic in question and the Holland types violates the order predictions of the RIASEC circumplex. If the order predictions are violated, and the R^2 value obtained in the analysis is above .50, then the resulting angle of integration may be somewhat surprising to readers who are familiar with Holland's theory.

These counterintuitive findings have several potential interpretations. First, it is possible that the measures in question could be revised to more closely match the full set of order predictions in Holland's (1959, 1997) theory. Second, it is possible that the Holland type definitions will require some revision as a wider range of individual-differences measures are integrated into the proposed atlas model of the world of work. And third, it may simply be the case that not all individual-differences measures that are relevant to the career choice and development process can be accounted for in a two-dimensional circumplex model. Additional research is needed to evaluate the relative merits of each of these interpretations for characteristics that produced unexpected results, such as Dominance, Authority, Academic Achievement, and Shrewdness.

In addition to structural issues related to using Holland's (1997) model as an integrative framework, another potential issue with our results is the range of measures and data sets used in the structural analysis. There may be a preference among some readers for a more meta-analytic approach, that is, an exhaustive review focused on one measure or area instead of the wide range represented here. Although that type of research can provide interesting results, our present goal was to explore the integrative potential of an interest-based circumplex structure and illustrate prospective applications of the approach across a wide range of constructs. Having demonstrated the utility of this approach, we have opened the door for more exhaustive surveys of the research on specific measures.

Integration Along the People–Things Dimension

A dominant organizational element of the interest circumplex is the differentiation between those individuals who prefer involvement with people and those who prefer involvement with things. The distinction between people and things is a recurrent theme in the interest literature dating back to Thorndike (1911), was empirically documented by Thurstone (1931), was used as a dimension in the Holland model by Prediger (1982), and is analogous to the sociability dimension proposed by Hogan (1983). A number of personality characteristics fit into the circumplex structure in an arc encompassing the range of environments that involve working with people, the S and E types. These include the five-factor-model-based measure of Extraversion, the MBTI Extraversion–Introversion scale, and the JVIS and CSPC measures of Interpersonal Confidence.

The results of the second study provide additional support for the differentiation between those individuals who prefer interacting with people and those who prefer interacting with things. This things-oriented arc encompasses the region of the circumplex in which individuals spend more time engaging with objects and tools and less time interacting with people. Perhaps what is most notable in the results fitting environmental demands into the integrated model is that many of the environmental measures tend to be oriented toward the things end of the interest continuum, whereas the personality measures tend to emphasize the people end of the continuum. For environments that place an emphasis on interacting with things and objects, there is wide range of information about the abilities required for successful engagement, but comparatively little in the way of personality measures for things-oriented people. In comparison, the range of environmental information for people-oriented work environments is smaller, but there are a number of personality measures reflecting an orientation toward people. Our results suggest that additional work may be necessary to identify people-oriented ability constructs and things-oriented personality constructs.

Integration Along the Structured–Dynamic Dimension

Another dominant organizational element of the interest circumplex is the differentiation between those individuals who prefer structured environments in which activities are regimented and tasks are clearly defined in advance and those who prefer more dynamic environments in which specific tasks are not defined as clearly and an emphasis is placed on creative activities. These results are somewhat consistent with Hogan's (1983) conformity dimension. For example, the five-factor-model-based measure of Openness to Experience, which can be interpreted as the inverse of conformity, contrasts the A and C types. The dynamic constellation can be seen in the arc of property vectors pointing toward the A type in the interest circumplex, including measures of Openness to Experience, Independence, Imagination, Originality, Creativity, and fluency of ideas. The structured constellation can be seen in the arc of property vectors pointing toward the C type in the interest circumplex, including measures of Conscientiousness, Sensing, Conformity, clerical ability, and the Supervision reinforcers.

Complexity and the Third Dimension of Interests

In the third study, ability requirements were fit into the third dimension of an interest structure, which suggests that general ability level may be an underlying organizational element of this dimension. It is interesting to note that this dimension emerged in an interest structure, which suggests that interest in complexity of work is an important factor to consider in applied settings. In this context, complexity refers to the cognitive demands required by activities in an environment. The verbal ability requirements of written expression and written comprehension coincide nearly perfectly with the third dimension for the sample of O*NET occupations. In addition, vectors for the quantitative ability requirements of mathematical reasoning and number facility, when plotted, are located between the first and third dimensions. Overall, these findings are an independent confirmation of G. D. Gottfredson and Holland's (1996) complexity dimension using interest data. It should be noted that cognitive requirements, such as educational level, are correlated with occupational prestige (Blishen et al., 1987). Therefore, the current finding that cognitive complexity is an important component of the third dimension of interests should be compatible with prestige-based interpretations of the third dimension (i.e., Tracey & Rounds, 1996). Additional work is needed to clarify the relationship between cognitive complexity and occupational prestige in the proposed Atlas of Individual Differences.

A potential concern with the three-dimensional interest model used in the present study is the methods used to develop it. Compared with the two-dimensional RIASEC circumplex, our three-dimensional alternative is more tentative and exploratory. It should be noted, however, that the obtained results were consistent with the proposed addition of a complexity dimension to the RIASEC model (see G. D. Gottfredson & Holland,1996; Rounds & Day, 1999). Given the previously discussed limitations of the Holland types, the potential exists for the development of a more comprehensive model of interest structure with an increased potential to serve as an integrative framework. In particular, it seems likely that future research on integrating individual differences using a framework based on a basic interest structure will provide an enhanced representation of the connections between cognitive abilities and other constructs.

An Atlas of Individual Differences

The individual-differences domains being integrated here are distinct sets of characteristics, and each area is supported by a substantial body of empirical research. Rather than supplanting the essential information covered by each domain, the integrated model presented here augments previous research by providing a common interpretive framework and identifying recurrent themes across domains. Additionally, our results suggest that a single structure-based map of individual differences will not be sufficient to represent the full range and complex nature of human functioning. Instead, we propose that the development of an atlas of individual differences integrate a diverse range of psychological constructs using more than one structural model (e.g., Hough & Ones, 2001). In this context, our results represent a starting point for pursuing integration. It will be important to expand the range of characteristics incorporated into the atlas and also to explore the potential utility of other structures, such as the hierarchical models prevalent in the ability measurement area (Lubinski & Dawis, 1992).

The central finding presented here is the importance of context for understanding how individual-differences characteristics are interrelated. What we have mapped appears to be the product of a complex, iterative developmental process whereby individuals find ways to function effectively in their environment. Notwithstanding the important unique contributions made by researchers working in the areas of personality, interests, and ability requirements, it is the recurrent themes that emerge across these domains that provide new insight into how individuals function in environments. Individuals with more extraverted personalities have an interest in environments in which there is more social contact, and they develop the necessary skills to function effectively. A similar congruence is found in individuals with more introverted personalities and their environments, in which there is less social contact. Individuals who are more open to new experiences are interested in more dynamic and fluid environments in which they can develop and express creative skills. In comparison, individuals who are more conforming will be interested in more structured, supervised environments where they can develop and use organizational skills. A third dimension provides separation between environments and individuals on the basis of complexity of work tasks and cognitive ability level.

The identification of constellations of individual-differences variables offers a new organization perspective for future research. In general, taxonomies are important for developing hypotheses, generalizing across events, and understanding research results (Fleishman & Quaintance, 1984; Hough & Ones, 2001). For example, when designing a meta-analysis there is often some difficulty in deciding which measures to include in particular analyses due to concerns over accurate categorization. An atlas mapping the relative locations and associations between measures would provide a framework for organizing this type of research. The development of a spatial taxonomy organized around a circumplex structure could also serve as a catalyst for the development of alternative integrative structures, especially in the case of researchers who prefer hierarchical models. Unfortunately, at this time we are unaware of any statistical techniques that are equivalent to property vector fitting for use with hierarchical models such as the one proposed by Gati (1979, 1991).

Our results provide some indication of areas of individual-differences measurement in which additional work is necessary, such as the development of measures of interpersonal ability requirements. The development of new individual-differences measures that provide a more complete picture of how individuals function in environments will increase the potential effectiveness of these measures in applied settings, such as career counseling. Organizing individual-differences information around an interest structure provides an important contextual framework for understanding the interrelations between measures, and this will also increase the potential effectiveness of these measures. The development of an integrated model of individual differences would provide a template for the more coherent and systematic delivery of information in career counseling and other applied settings.

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